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SUPPLEMENT 163

ROOTROTS AND LEAFSPOTS OF GRAINS AND GRASSES IN THE NORTHERN GREAT PLAINS AND WESTERN STATES

Supplement 163 June 15, 1946

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PLANT DISEASE REPORTER SUPPLEMENT

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station Beltsville, Maryland

ROOTROTS AND LEAFSPOTS OF GRAINS AND GRASSES IN THE NORTHERN GREAT PLAINS AND WESTERN STATES[1]

Roderick Sprague[2]

Plant Disease Reporter
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INTRODUCTION

As delimited by the title, this annotated list contains at least mention of all the parasites known by the writer to attack Gramineae in the western United States. Since he has experienced difficulty in staying abreast of the literature on these some 200 species of fungi on nearly 500 hosts, the writer has assembled this material primarily for his own use. While the resulting preliminary work is not a text, it is somewhat more than a list and it seems that it may have some value to a number of western experiment station workers and field men in the routine diagnosis and study of the lesser known leafspot and rootrot diseases of grasses and cereals. Since brevity has been necessary it appeared to the writer that some of the better known parasites could be given less space than some of the lesser known ones, as information on the latter frequently is buried in obscure journals. Most of the important diseases of cereals have been well covered in such standard texts as Heald's Manual (316)[3], Owens (497), Chester (103), and Dickson (160). This article, then, may be useful as a supplement to available texts.

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[1] Cooperative investigations between the Divisions of Cereal Crops and Diseases, Forage Crops and Diseases, and Soils, Fertilizers, and Irrigation, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration; and the Division of Nurseries, Soil Conservation Service, U. S. Department of Agriculture; and the North Dakota Agricultural Experiment Station.

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This outline is the result of work started about 15 years ago at Corvallis, Oregon, and is partly a direct outgrowth of several check lists issued in 1935, 1937, and 1942. The writer felt that the regrassing program, started during and after the dry years of the last decade, would eventually require more information on the fungi of Gramineae than was then available. There were others soon interested in studying this neglected field. The recent and current work, for instance, of Fischer on fundamental taxonomy of the smuts of grasses has added a great deal of needed data on this group. Research in the Canadian provinces on rootrots, the studies made at Iowa State College on Pythium spp., and the publication of such texts as Grove (296, 297) and Sampson and Western (572) have aided workers during recent years. There is a new publication by Garrett (257), which gives a modern and understandable summary of the epidemiology of rootrots in general. The recent text by Gilman (262) is also helpful in determining common soil molds associated with parasitic root fungi, as are texts by Thom (705), Jensen (362), Boedijn (55), and Clements and Shear (117), and the Checklist by Weiss (755-757).

The region covered herein is by no means thoroughly explored from our viewpoint. However, during the past decade various workers have collected and studied intensively in widely scattered parts of it. Probably the greatest impetus to this work has been the increase in knowledge of the hosts through the publication of Hitchcock's manual of the grasses (326) and the increase in the number of workers who are able to determine the hosts with a fair degree of accuracy. We therefore find that the western part of the United States is, in general, as well covered as the eastern part. Seymour (599) contains about 2,820 citations (hosts x fungi) of parasitic fungi for all of North America on Gramineae, while the unpublished list of the writer and Fischer includes 3257 citations for the western area alone. Since Seymour's list appears to contain very few western citations other than rusts and smuts it is apparent that the recent investigations have greatly expanded the host range on Gramineae in this once neglected region.

This article includes reference to about 221 species and sub-divisions of species of parasitic fungi found growing naturally in the region. There are 13 Phycomycetes, 24 Ascomycetes (if we include 15 species of Phyllachora), 8 Basidiomycetes, and 162 Fungi Imperfecti, as well as a few undetermined or non-parasitic troubles. In addition, brief mention is made of associated non-parasitic saprophytes which are sometimes such early invaders of dead tissue that they have been considered as weakly parasitic in some cases. The following table indicates the number of species of leafspot and rootrot-causing fungi reported on Gramineae in the several western States.

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[3] Figures in parentheses refer to "Literature cited," p. 215.

Number of species found in:	Class of fungi					
	Phycomycetes	Ascomycetes	Basidiomycetes	Fungi Imperfecti	Miscellany	Total
North Dakota	8	11	3	79	4	105
South Dakota	7	9	1	49	0	66
Minnesota	6	7	4	43	2	62
Iowa	7	7	2	35	1	52
Nebraska	5	10	1	42	0	58
New Mexico	1	9	0	7	0	17
Arizona	1	5	0	5	2	18
Colorado	1	5	0	13	1	20
Utah	0	3	2	10	1	16
Wyoming	2	3	2	40	0	47
Montana	8	5	4	45	0	62
Idaho	0	4	3	30	2	39
Washington	5	6	4	67	2	84
Oregon	6	7	4	97	1	115
California	3	9	1	47	3	63
Nevada	0	0	0	1	0	1
Alaska	0	1	0	5	0	6

It is evident from the table that Oregon, North Dakota, and Washington have been the most thoroughly explored. Some States such as Nevada have very few fungi reported on Gramineae other than rusts and smuts. Of course climate influences these records tremendously. The coast region of Oregon, Washington, and northern California is highly favorable to the development of leafspot fungi while some of the Rocky Mountain areas also harbor a large number of them. The arid plains have few leaf spots but many rootrot fungi and late-summer leaf spots occur in the Northern Great Plains. The wooded and swamp areas of Minnesota contain numerous leaf spots.

An intensive survey has been conducted in Washington and North Dakota on exotic hosts in the large grass nurseries at Pullman and Mandan. Therefore the greatest host range (fungi x hosts) occurs in North Dakota with 1,369 citations to all fungi including smuts and rusts. Washington has 971 citations, Oregon has 912 (mostly on native species), South Dakota 497, Montana 460, Minnesota 445, California 437, Nebraska 331, Iowa 327, Wyoming 282, Colorado 264 (mostly rusts and smuts), Idaho 262, Utah 152, New Mexico 133, Arizona 133, Alaska 40, and Nevada 39. This indicates approximately which States need additional survey information.

While the majority of the cereal diseases are well covered in plant pathological literature, many of the fungi causing grass diseases are scarcely mentioned except for the original mycological description. Therefore it is still necessary for workers with these fungi to be acquainted with the location of these descriptions as well as where the type material or comparable exsiccati may be found. Material available from the western area is not plentiful among the earlier collections. David Griffith's *Western American Fungi* contains numerous smut fungi but few of the fungi that fall within the bounds of this study. Brenckle's *Fungi Dakotensis*, Ellis and Everhart's and associates' various collections, and Cooke's recent *Mycobiota* series contain some collections, while Solheim's *Mycoflora Saximontanensis* is also useful. Most of the material dealt with by the writer is filed either at Oregon State College, Corvallis, Oregon; or is in the Mycological Collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, Beltsville, Maryland. Some of this material is scanty and of use for record only, but an attempt was made to preserve a fairly complete record of recent collections.

In this article, the fungi are listed alphabetically under the classes: (1) Phycomycetes, page 105, (2) Ascomycetes, page 111, (3) Basidiomycetes, page 116, and (4) Fungi Imperfecti, page 120. No attempt has been made to give an exhaustive list of references, but instead only those are included that are considered necessary for a working basis. It has not been possible to check all references against the originals and therefore considerable use has been made of abstract journals.

In discussing the various fungi, usually brief summaries are given of symptoms, host range, and sometimes morphology; and less often of taxonomy.

PHYCOMYCETES

APHANOMYCES SPP. Root Necrosis.

Pure cultures of Aphanomyces have been isolated from oats growing in acid soil in northern Minnesota, eastern Montana, and in the coast region of Oregon. Scattered isolates have also been obtained from meadow fescue (Festuca elatior L.), red fescue (F. rubra L.), and green needle grass (Stipa viridula Trin.) from Mandan, North Dakota, and from Setaria viridis (L.) Beauv. mingled with oats in eastern Montana. The only place where there was very much evidence of damage was in the very red, very acid soil in Lincoln County, Oregon, and even in this instance the fungus was associated with so many other organisms that its exact role was not readily determinable (Sprague, 639). The culture from northern Minnesota appears to be A. camptostylus Drechs., which is a somewhat delicate-appearing fungus originally isolated from diseased oat roots at Sauk City, Wisconsin, by M. B. Linford. The writer worked with this fungus in 1926 at Madison and has found that some of his recent isolates were similar in appearance. No study has been made with these forms in North Dakota as yet, because they appear to be less important than a number of other fungi. However, as species of Aphanomyces are somewhat difficult to isolate, they may be more prevalent than our occasional isolates would indicate. They are evidently of more importance in northern Minnesota and in the coast region in Oregon.

References: Drechsler (181, figs. 9-11); Sprague (639).

PHYTOPHTHORA SPP., Rot.

Phytophthora cactorum (Leb. and Cohn) Schroet. and some undetermined forms are sometimes found associated with soft rots of the leaves and roots of grains and grasses. While corn is the most frequently reported host (Sideris, 606), the following have been noted: quack grass (Minnesota), Triticum durum Desf., Agropyron sibiricum (Willd.) Beauv., Hordeum jubatum L., and Stipa viridula Trin. in North Dakota, Lolium multiflorum Lam. (Oregon), Poa vaseyochloa Scribn. (Oregon), and Avena fatua L. (Oregon and California). This fungus needs abundant moisture to be able to develop parasitically.

McMurphy (450) noted a species similar to Phytophthora calocasiae Rac. (Tucker, 716) on oats in California. The infected areas were at first yellowish, then whitish, and finally brown or reddish brown. The fragmentary material seen by the writer on wild oats (Avena fatua) near The Dalles, Oregon, and in northern coastal California were only water-soaked leaves in contact with the soil. The North Dakota isolations were from roots of seedlings and were usually associated with other fungi. The most abundant material that the writer has obtained was in stunted plants of barnyard grass growing near Belle Fourche, South Dakota. This material appeared to be P. cactorum. A similar fungus was isolated from corn roots near Newell, South Dakota, at the same time. In the greenhouse at Mandan artificial inoculations with this fungus (inoculum added to soil at seeding time) caused 88 percent loss in Turghai proso, only 6 percent loss in crested wheatgrass, scarcely a trace in wheat, 70 percent in Ladak alfalfa, 71 percent in blue grama, and only a trace in corn. Its injury was confined to seed rot at the temperature employed (48° to 70° F). In general, Phytophthora is not important on Gramineae.

References: McMurphy (450); Sideris (606); Tucker (716, 717).

(?) SYNCHYTRIUM SP., Purple Leaf Speckle.

In 1942, the writer (656) stated that this fungus was a "primitive unilocular body or cluster of large cells imbedded in a leaf spot." There is no appreciable gall formation and for that reason it was doubted that the fungus was a species of Synchytrium. It appeared to be nearest to Eurychasmidium (Karling, 377) of the Ectrogellaceae. However, recent illustrations by Cook (124) of species of Synchytrium from Louisiana more strongly suggest that this fungus could be placed in Synchytrium. We have not been able to find mention of a similar fungus on grass unless it be the somewhat vague Protomyces rhizobius Trail, which occurs on Poa annua L. in Scotland. There is, however, little or no mycelium present in the material from Oregon and Washington. Protomyces is placed in either the Phycomycetes or the Ascomycetes, depending on the authority.

In Oregon and Washington, the fungus is relatively common but seldom destructive during open, wet, winter weather in the Willamette Valley of Oregon, and the coastal region of both States. It is sometimes found on bent grass lawns at Corvallis. It occurs on Agrostis alba L., A. canina L., A. exarata Trin., A. hallii Vasey, A. palustris Huds., A. tenuis Sibth., Anthoxanthum odoratum L., Bromus carinatus Hook. and Arn., Dactylis glomerata L., Elymus glaucus Buckl., Festuca rubra var. commutata Gaud., Poa annua L., P. juncifolia Scribn., P. pratensis L., and P. secunda Presl. Representative material is filed at Oregon State College and at Harvard University.

References: Cook (124); Karling (377); Sprague (655, 656).

PYTHIUM ARISTOSPORUM Vanterpool
Root Browning of Grains, Seedling Blight of Grasses.

This fungus is closely related to the much more abundant Pythium arrhenomanes Drechs. In the United States it has been isolated from wheat, crested wheatgrass (Agropyron cristatum (L.) Gaertn.), orchard grass (Dactylis glomerata L.), barnyard grass (Echinochloa crusgalli (L.) Beauv.), and tall meadow oatgrass (Arrhenatherum elatius (L.) Beauv.) at Bozeman, Montana, on barley at Dickinson, North Dakota, and on this host and oats near Eugene, Oregon, and on slender wheatgrass (Agropyron trachycaulum (Lk.) Malte) at Mandan, North Dakota. Like P. arrhenomanes this species produces a wet-appearing pebbly growth on potato-dextrose agar, but the oogonia with their numerous antheridia do not disintegrate quite as fast as do those of P. arrhenomanes. The oogonia also appear to be larger in P. aristosporum.

References: Sleeth (614); Vanterpool (739, Fig. 2, Pl. XXII; 743); Vanterpool and Sprague (744).

PYTHIUM ARRHENOMANES Drechs.
Root Browning of Grains, Seedling Blight of Grasses.

Root browning is characterized by dark brown lesions on the small roots of small grains (wheat, oats, barley) in late May and June in the Northern Great Plains and adjacent regions. The plants when severely infected show a pale green color in contrast with healthy ones. This fungus is very widespread in all of the northern plains States and also causes a serious seedling blight of sorghum in the Sacramento Delta region of California. It is the well-known cause of Milo disease in the Great Plains. The most serious aspect of this fungus is its effect on spring-seeded grasses in North Dakota, South Dakota, Nebraska, and Minnesota. It causes a blight of the young plants, which wither and die about 6 weeks after seeding. During some years, almost 100 percent kills have occurred in crested wheatgrass, slender wheatgrass, and smooth brome (Bromus inermis Leyss.) at Brookings, South Dakota, and in places in North Dakota. The host range is very great (Vanterpool and Sprague 744). Curzi (134) reports a similar disease on cereals in Italy but the identity of the Italian fungus has not yet been determined.

Drechsler (185) contends that his Pythium arrhenomanes (179) is distinct from P. graminicolum Subr. (692) because, "the close mycelial connection between oogonium and antheridium, very frequent in P. graminicolum, is rare in P. arrhenomanes; and in parallel cultures the sturdy, more substantial membranous parts of the sexual apparatus of the former species remain clearly discernible long after the evanescent antheridial envelopes and supporting branches of the latter have become nearly or wholly invisible." On the basis of this distinction the material in the Northern Great Plains is P. arrhenomanes, except P. aristosporum which has the long-lived traits of P. graminicolum in pure culture. Both *P. arrhenomanes* and *P. graminicolum* are recognized by Matthews (440).

Root browning in Saskatchewan (Vanterpool, 740, 742)is partly checked by judicious use of phosphate fertilizers wherein a proper balance of nitrogen is maintained. Hanson (306) has obtained striking results in the control of rootrot at Lamberton, Minnesota, by the use of phosphate or phosphate and nitrogen fertilizers on wheat. The writer obtained similar results in the coast region of Oregon, but in the Northern Great Plains where most areas are not yet deficient in phosphorus and where nitrogen is not seriously deficient, fertilizing has not had much effect on root browning, except that recent trials with ammonium phosphate (16-20-0) indicate that this material may have some effect on the parasite as well as on the host. Partial control of the rootrot complex in wheat with 100 lbs. of ammonium phosphate per acre in trials at McCanna, North Dakota, have shown particular promise (Sprague, annual report, 1945).

Since *Pythium arrhenomanes* is restricted to Gramineae, use of non-grass plants in rotation reduces its injury. Among cereals oats are most tolerant; proso millets (*Panicum miliaceum*) or sorghums usually are less desirable to grow. While fallow does not appear to increase the amount of *Pythium* it creates the same effect by starving out other organisms, permitting the *Pythium* forms temporary ascendancy. Small-seeded grasses should not be seeded on fallow if it can be avoided, at least not in the spring of the year. Crested wheat grass, whoever, can be sown on fallow under most conditions. Fall seeding is preferred to spring seeding where conditions permit. Even winter seeding of crested wheatgrass is preferred if periods of open weather occur as is sometimes the case in North Dakota.

References: Andrews (14); Bowman et al. (61); Branstetter (63) Buchholtz (78); Carpenter (92); Conners and Savile (123); Curzi (134); Drechsler (179, 185); Edgerton, Tims, and Mills (194); Elliott et al. (204, figs. 1-8, 17, 21); Flor (232); Hanson (306); Ho and Melhus (330); Ho et al. (331); Ho and Koepper (329); Hoffmaster (333); Johann (364); Kendrick and Briggs (380); Leukel (403, fig. 1); Matthews (440); Melchers (455); Melchers and Lowe (456, 457); Melhus, Martin, and Murphy (460); Middleton (465); Rands and Dopp (523, 524, 525); Roldan (539, 540); Sallans (567); Simmonds, Russell, and Sallans (611); Sprague (658, 661, 663); Sprague and Atkinson (670); Subramaniam (692); Vanterpool (737, 738, 739, 740, 741, 742, 743); Vanterpool and Sprague (744); Vanterpool and Truscott (745); Wagner (749).

PYTHIUM DEBARYANUM Hesse, *P. IRREGULARE* Buis., *P. ULTIMUM* Trow

Seed rot, Damping-off and Root Necrosis.

Although two of the originally recognized hosts of *P. debaryanum* were *Panicum miliaceum* L. (proso millet) and *Zea mays* L. (Hesse, 325), this fungus is little recognized as a parasite of Gramineae. However, Eriksson (219) and also Gram and Rostrup (281) report it on barley, and there are a number of citations on cane crops, including corn, (Ho, 328). In the Northern Great Plains, *P. debaryanum* and related species cause considerable seed rot in wet soil in the spring and may cause damping-off or seedling injury to some small-seeded grasses (Sprague, 665). Sometimes when cereals are planted in low wet ground or when old moldy seed is planted in heavy ground *Pythium* will cause seed rot. The injury in most cases in both grasses and cereals occurs just as the seed sprouts. The rootlets are unable to emerge. In the greenhouse under artificial conditions some grasses have the roots reduced to yellow or brown stubs even after emergence. There are various strains of these fungi that will attack some hosts more readily than others. Some will attack certain cereals, such as wheat, barley, and oats, more severely than others; some strains from grasses will attack many species of grasses but are mildly parasitic on non-grass crops; while in other cases the reverse is true. In general, however, the host range is so great that crop rotation to control this group would be very difficult to work out. Since legumes, notably alfalfa, are very susceptible to *P. debaryanum* (Buchholtz, 79) and fallow seems to favor it, the control of *P. debaryanum* becomes even more difficult than that of *P. arrhenomanes*, which is confined to the grass family. However, *P. debaryanum* is usually not an important parasite on wheat and usually does not cause the complete destruction on grasses that seedling blight (*P. arrhenomanes*) does. Buchholtz (78) has shown that seedling blight symptoms are produced by *P. arrhenomanes* (called *P. graminicolum* by him). We have found that recovery from *P. debaryanum* is very rapid and from *P. arrhenomanes* very slow, in many grasses, in the recovery period after the June seedling blight days have passed. *P. debaryanum* is, therefore, mainly important as a seed rot but can cause some root necrosis. Oats are somewhat more susceptible to *P. debaryanum*, especially during cool, wet weather (Welch, 758; Gram and Rostrup, 281; Beaumont, 29).

Pythium debaryanum, *P. ultimum*, and *P. irregulare* belong to the sphaerosporangial group of *Pythium* spp., that is the sporangia are spherical or lemon-shaped. On the other hand, *P. aristosporum* and *P. arrhenomanes* produce irregular, lobed or lobulate swollen bodies, from which stalked spherical sporangia develop later. *P. debaryanum* is by far the most common of the sphaerosporangial forms on Gramineae in North Dakota. *P. ultimum* is common in the Palouse region near Pullman, Washington, in the heavy Palouse silt loam in early season. *P. irregulare* is scattered but not uncommon on oats and brome grasses (*B. inermis*, *B. tectorum* L.). It is distinguished from the other two by its irregular oogonial wall with prominent projections. *P. debaryanum* produces zoospores from the sporangia, but *P. ultimum* germinates direct by sending out germ tubes from the sporangia. In addition, in P. ultimum the antheridia arise from the oogonial stalk while in P. debaryanum the several antheridia are likely to be produced from distinct, distant hyphae. P. vexans DBy. is another sphaerosporangial species sometimes encountered on grasses and cereals, more or less readily distinguished by its broadly appressed antheridial attachment. Also, P. hypogynum Middleton (464) probably occurs in North Dakota on wheat (Sprague isolation notes). This fungus has the antheridium growing up through the oogonial stalk. Still another related species, P. iwayamai Ito (Ito and Tokunaga 355), was said to cause a snow rot disease of cereals in Japan (Iwayama, 356), but this has not been seen in the United States. Biraghi (48) reported P. polymorphon Sideris (606), which may be the same as P. irregulare, on wheat from Italy.

References: Beaumont (29); Biraghi (48); Buchholtz (78, 79); Butler (87); Drechsler (178); Eddins (192); Eriksson (219); Gram and Rostrup (281); Grandfield, Lefebvre, and Metzger (282); Hesse (325); Ho (328); Ho and Melhus (330); Höhnk (335); Ito and Tokunaga (355); Iwayama (356); Matthews (440, pl. 17, fig. 17-21,22,24,25); McLaughlin et al. (449); Melhus et al. (461); Meredith (462, 463); Middleton (464, 465); Miura (471); Petri (513); Ramakrishan (522); Sideris (606); Sprague (658, 663, 664); Spyshneva (677, 678); Van Luijk (736); Vanterpool (743); Welch (758, 759).

PYTHIUM MONOSPERMUM Pringsh., Root Necrosis.

(P. complens A. Fischer)

Pythium monospermum was isolated from mildly necrotic roots of Turghai proso millet at Mandan, North Dakota, and from Sporobolus cryptandrus (Torr.) A. Gray near Buffalo, South Dakota. It has filamentous or semi-lobulate branched sporangia. An inoculation trial at Mandan with the Mandan isolate caused 62 percent loss in crested wheatgrass, 100 percent loss in alfalfa and blue grama (Bouteloua gracilis (H.B.K.) Lag.) 31 percent in wheat, 28 percent in oats, and only 4 percent in corn. It should be added that Drechsler (177) could not infect cabbage heads with P. monospermum, but with the culture at Mandan, 98 percent preemergence seedling kill was obtained in Chinese cabbage and 100 percent in tomatoes. P. monospermum appears to be rare in the Northern Great Plains.

References: Drechsler (177); Matthews (440); Middleton (465).

PYTHIUM PERIILUM Drechs., Root Necrosis.

What appears to be Pythium periilum was isolated from the roots of quack grass (Agropyron repens (L.) Beauv.) in a gray, glacial soil near Bemidji, Minnesota. The oogonia were similar to those illustrated by

Drechsler in one of his remarkable drawings (186, fig. 5). The culture from the Bemidji material died before its pathogenicity could be tested. Stevenson and Rands (685) and Rands and Dopp (524) stated that it was feebly parasitic on sugar cane roots. Further study is needed with this Minnesota form.

References: Drechsler (183, 186); Rands and Dopp (524); Stevenson and Rands (685).

PYTHIUM ROSTRATUM Butl., Root Necrosis.

Pythium rostratum was isolated in May 1942 from roots of *Avena sativa* L. at Pullman, Washington. It is generally considered to be a soil saprophyte and no data is available on whether it is parasitic on oats. It was associated with mild root necrosis.

References: Butler (86); Matthews (440, pl. 17); Middleton (465).

PYTHIUM TARDICRESCENS Vanterpool, Root Browning.

Vanterpool found *Pythium tardicrescens* moderately common in Saskatchewan, Canada, but it has been found only twice in the United States, once on *Avena fatua* L. at Pullman, Washington, and once on barnyard grass at Graceton, Minnesota. It produces a firm, dark brown rot or root browning, and in our trials has about the same host range and relative pathogenicity as the other lobulate sporangial species such as *P. arrhenomanes*. The oogonia generally average smaller than *P. arrhenomanes* and have a characteristic sub-globulate content. The fungus produces a weak scanty growth in culture on corn-meal agar and only a few oogonia mature.

References: Sprague (658; 663); Vanterpool (739, fig. 1, pl. XXII; 740; 743).

ASCOMYCETES

DOTHICHLOË LIMITATA Diehl, Leaf Disease.
(*D. atramentosa* (Berk. and Curt.) Atk.)

Diehl (170) described *Dothichloë limitata* as having white conidial masses on the upper leaf surfaces of infected leaves. While the fungus is largely found in warm temperate areas, it ranges as far north as North Dakota where it occurs on *Calamagrostis inexpansa* A. Gray. Diehl believes that this fungus is systemic and that it causes sterility in the grasses it attacks. Low temperatures inhibit its fructification and no doubt limit its northward distribution.

References: Chardon (102, pl. 14, fig. 12); Diehl (168, pl. 2, *D*, *E*, and fig. 3, *B*; 170, pl. 1).

DOTHIDELLA ARISTIDAE (Schw.) Ell. and Ev.

(*See Septogloeum oxysporum* Sacc., Bomm. and Rouss. in the Fungi Imperfecti, p. 170).

EPICHLOË TYPHINA (Fr.) Tul., *Cat-tail Disease or Choke*.

Epichloë typhina forms a cylindrical collar of creamy, later dark orange stroma around the culms of various grasses, causing some sterility. In North Dakota it has been found on Canada bluegrass (*Poa compressa* L.), Kentucky bluegrass (*P. pratensis*), Sandberg bluegrass (*P. secunda*), western wheatgrass (*Agropyron smithii* Rydb.), slender wheatgrass (*A. trachycaulum*), Virginia wild-rye (*Elymus virginicus* L.) and Junegrass (*Koeleria cristata* (L.) Pers.). At Pullman, Washington, it is found on *Agropyron spicatum* (Pursh) Scribn. and Sm., *A. trachycaulum*, *Elymus canadensis* L., *E. dahuricus* Turcz., and *Poa stenantha* Trin. It occurs also at Whitehall, Montana, on *Agropyron smithii*. It occurs on timothy and Kentucky bluegrass in Nebraska, on slender wheatgrass in Montana, on Junegrass in South Dakota, on *A. inerme* (Scribn. and Sm.) Rydb. at Athol, Idaho, and on *Hystrix patula* Moench in Minnesota. It is more spectacular than important in most cases.

References: Sampson (568, 569); Stevens (682).

GIBBERELLA ZEAE (Schw.) Petch. See *Fusarium graminearum*, Schw. p. 181.

LEPTOSPHAERIA HERPOTRICHOIDES De N., *Secondary Rootrot*.

Leptosphaeria herpotrichoides was, for many years, believed to be the main cause of straw-breaker footrot of cereals, especially wheat, in Europe. Research has shown that it is actually only a questionable, weak parasite (Sprague, 620; 622; Sprague and Fellows, 671) and it is seldom mentioned in recent literature, *Cercosporella herpotrichoides* Fron having replaced it as the recognized cause of the straw-breaker disease in Europe and the Pacific Northwest.

Leptosphaeria herpotrichoides was found by the writer on dead culms of rye near Leonard, North Dakota, in 1940 and was reported on wheat from Peone Prairie, Washington, by McKinney (446, p. 29).

References: Delacroix (147); Henry and Foster (324); Mangin (432); McKinney (446); Sprague (620, 622); Sprague and Fellows (671).

MYCOSPHAERELLA TULASNEI (Jancz.) Rothers, *Leaf Mold*
(*Cladosporium herbarum* Lk.)

The conidial stage (*Cladosporium herbarum*) is an omnipresent saprophyte. There are some indications that in early spring it is parasitic on the leaves of certain grasses, notably western wheatgrass at Mandan and Idaho fescue (*Festuca idahoensis* Elmer) in the far west. It produces brown flecks on the young leaves and forms a brown to olive-black mold on any of the above-ground parts after the plant dies. There is some doubt about whether it is parasitic on the young leaves of western wheatgrass at Mandan, North Dakota, because it usually follows early spring low-temperature conditions. In addition to the early season condition, it is often associated with leaf rusts and with such leaf parasites as *Septoria nodorum* Berk. It is seldom isolated from the roots of cereals and grasses.

The conidiophores of this species form dense tufts of velvety olive-black color. The conidiophores are more or less erect, septate, sparsely branched; spores often in chains of 2 or 3, sub-cylindric, pale olive, 1-(2-3) septate, 10-15 x 4-7 µ. Heald and Ruehle (317) presented evidence that the microsporous stage, *Hormodendrum cladosporioides* Sacc., is not conclusively part of the cycle of *M. tulasnei*. They verified (Ruehle 547, Heald and Ruehle, 317) the work of Janczewski (360) who determined that *M. tulasnei* was the perithecial stage of *C. herbarum*. The writer obtained *M. tulasnei* in a pure culture of *C. herbarum* in 1943, isolated from *Stipa viridula* in western North Dakota.

Ruehle in his work with fruit rots (547) reported the perithecia of *Mycosphaerella tulasnei* as black with thick walls, typically broadly flask-shaped with a short neck, erumpent, 150-250 x 100-150 µ; asci cylindrical, fusoid or slightly tapering at the ends, 80-120 x 15-20 µ; ascospores oblong, bluntly pointed, 1-septate, upper cell somewhat larger than the lower one, 18-28 x 6- 8.5 µ.

Cladosporium herbarum is probably one of several species of this genus on Gramineae, but without sufficient critical modern study, the writer follows precedent in assigning them all to *C. herbarum*. *C. graminum* Cda. is frequently used also. Its distinction from *C. herbarum* is not clear. Schnellhardt and Heald (586) report *C. malorum* Ruehle as common on wheat seeds in Washington.

Cladosporium herbarum is probably not important in its role as mold on shocked or standing grain but seed treatment with New Improved Ceresan is recommended, as its presence often indicates occurrence of more virulent forms also.

Mycosphaerella tassiana (De N.) Johans. has been found on grasses in the far west but it is evidently not related to the *C. herbarum* complex. Cash (97) listed *M. longissima* Fckl. on *Bromus secalinus* L. from Sitka, Alaska.

References: Bennett (31); Bockmann (54); Cash (97); Heald and Ruehle (317, fig. 9; 13, *O*, *P*, *Q*); Janczewski (360); Ruehle (546, 547); Schnellhardt and Heald (586).

OPHIOBOLUS GRAMINIS Sacc., Take-all.

In the region covered by this paper, take-all occurs in Oregon, Washington, Idaho, and northern California. During the historically open winter of 1933-34, it was found on the Idaho prairies near Nezperce, where it occurs but is so inhibited during most years as to be unrecognized. In addition to western Oregon, it occurs also in trace amounts in the Grand Ronde Valley, Oregon. In 1930 it was found in irrigated spring wheat at Jerome, Idaho (Sprague, 621).

Take-all appears to be native in the Pacific Northwest, although it was not noticed until 1901 at Albany, Oregon (Cordley, 129)[4]. It occurs in virgin soils on *Holcus lanatus* L., high in the hills of the Coast Range in Oregon and has been found on *Bromus orcuttianus* Vasey in the Siskiyou Mts., Oregon. It is particularly common on annual fescues (*Festuca dertonensis* (All.) Aschers. and Graebn., *F. megalura* Nutt., *F. myuros* L.) in the Willamette Valley, in Newberg sandy loam, and in the greenhouse at Corvallis, Oregon, it is a nuisance in unsterilized soil. While *O. graminis* is important mainly on winter wheat and winter barley, it has been collected also on winter oats in acid soil in coastal Oregon and California. It was relatively common on these hosts during the year 1933-34 and was found in the Willamette Valley as well as along the coast. A trace of take-all was noted on *Poa canbyi* (Scribn.) Piper at Pullman, Washington. Fraser, Simmonds, and Russell (238,a) believed that *O. graminis* was indigenous to north-central Alberta.

The work of Fellows, Garrett, and the Canadian and Australian workers, has made *O. graminis* one of the most thoroughly studied fungi in the cereal rootrot complex. It needs plenty of study as it is a very uncertain parasite, here today and gone tomorrow. The worst infection the writer has ever encountered was in a plot of wheat seeded on land that had been in orchard for two decades or more.

Garrett's text (257) deals thoroughly with this fungus.

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[4] The still unlabeled specimens of this 1901 material were seen by the writer in 1933. They were definitely *Ophiobolus graminis*.

References: Åkerman et al. (3); Adam and Colquhoun (5); Broadfoot (69, 70, 71); Brommelhues (76); Buddin and Garrett (80); Bussman (85); Carne and Campbell (91); Clark (115); Cordley (129); Dana (137); Davis, R. J. (145); Fellows (223-228); Fellows and Ficke (230); Foster and Henry (236); Fraser (238); Fraser, Simmonds, and Russel (238,a); Garrett (242-258); Garrett and Dennis (259); Glynne (263); Griffiths (294); Henry (323); Hynes (346); Kirby (383); Laar, van de (395); Lal (396); Ludbrook (414); Ludwig and Henry (415); Mackie (423); Mangin (432); McAlpine (443); McKinney (446); McKinney and Davis (447); Melchers and Sewell (458); Moritz (474, 475); Müller-Kögler (478); Nattrass (480); Noll (490); Osborn (496); Padwick (498,499); Padwick and Henry (501); Robertson (537); Russell (548, 549); Samuel (573); Sanford (578); Sanford and Broadfoot (579); Simmonds (608); Simmonds, Russell and Sallans (611); Sprague (621); Stevens (683); Stumbo et al. (691); Turner (720, 721); Walker (750); White (764, 765); Winter (769-772, 774).

PHYLLACHORA SPP., *Tar Spots*.

The black, usually elongate, tar-like spots on grass leaves caused by various species of *Phyllachora* are classed as leaf spots. However, they represent a specialized group and as such have been carefully monographed recently by Orton (495). Since virtually all of the western material, including that of the writer, is discussed by Orton it is deemed satisfactory to refer this group to his work rather than discuss the group individually here. The publication (Mycologia) is readily available.

The tar spots are widespread and sometimes moderately important in reducing foliage, particularly on species of *Muhlenbergia* and on *Elymus canadensis* in our area. Studies on the life history of these forms is needed, particularly in reference to associated conidial and pycnidial forms.

Reference: Orton (495).

PYRENOPHORA BROMI (Died.) Drechs.

(The writer prefers to discuss this fungus under its conidial stage, *Helminthosporium bromi* Died., as it is one of a large number of species in this genus.)

SCLEROTINIA HOMOECCARPA F. T. Bennett, *Sclerotinia Turf Rot*.

Bennett (38) in England concluded that his earlier described *Rhizoctonia monteithianum* F. T. Bennett (36) was a species of *Sclerotinia*. *R. monteithianum* was said to be the same as the small *Rhizoctonia* turf or greens disease known generally as dollar spot (Monteith and Dahl, 472).

Since dollar spot occurs on the eastern edge of our area, *S. homoeocarpa* is included until critical work is available to verify or reject this classification. Probably the same fungus or fungi occur west of the Cascades in Oregon and Washington.

References: Bennett (36, 38); Keil (379); Monteith and Dahl (472); Struble (690); Tervet (704); Tyson (725).

BASIDIOMYCETES

ENTYLOMA SPP., Blister Smut on Leaves of Bluegrasses

The blister smuts of *Poa* spp. should be mentioned here because they can be and have been confused with tar spot fungi (*Phyllachora*). The stroma-like sub-epidermal chlamydospores form gray-black blister-like areas on the leaves of *Poa pratensis*, *P. compressa*, *P. juncifolia*, and *P. annua* in Oregon and adjacent Washington. The conidial phase of the fungus forms a fine, dried, amorphous series of dots scattered seriately along the surface of the blisters. The *Ramularia*-like sporidia of *Entyloma irregulare* Johans. from *Poa annua* germinated readily on potato-dextrose agar and produced flesh-color mucose masses of sporidia.

Entyloma spp. (*E. bingenensis* Zundel, in herb.) occurs abundantly on *Poa vaseyochloa* along the rocky warm slopes near Bingen, Washington, in late February or usually in March, as soon as growth starts and the first flowers appear (cfr. O.S.C. 8079, collected Feb. 25, 1935).

The two species, *Entyloma crastophilum* Sacc. and *E. irregulare*, are widely distributed but are especially prevalent, as mentioned, in western Oregon and Washington. They occur in the northern Great Plains and Minnesota. (?) *E. spragueanum* Zundel (782) from North Dakota is a fragment, needing further study. The entire group needs study.

References: Sprague (655, 656) Zundel (782).

CORTICIUM FUCIFORME (Berk.) Wakef., Pink Patch.

The fungus known generally as *Corticium fuciforme* but whose taxonomic status appears to be most uncertain has been reported by the writer from western Oregon (647). It develops on chewings fescue lawns during rainy periods in early spring. It also occurs on wild annual fescues, particularly *Festuca myuros* L. in Oregon.

References: Erwin (220, 221); Sprague (647).

RHIZOCTONIA SOLANI Kuehn,
Sharp Eyespot, Sheath Spot, Rootrot and Stem Canker (Strawbreaker), Brown Patch.

D. P. Rogers (538) places the basidial stage of R. solani in Pellicularia filamentosa (Pat.) Rogers based on Hypochnus filamentosus Pat. He gives Corticium vagum var. solani Burt ex Rolfs as a synonym, but C. vagum Berk. and Curt. is recognized as a common mold on woodland debris and is assigned to Pellicularia vaga (Berk. and Curt.) Rogers ex Linder. Because most of our material has not been connected with P. filamentosa, it is easier to employ the well-known R. solani for the purpose of this report.

R. solani is prevalent in most soils, particularly acid ones. It attacks a large number of grass hosts during wet weather in the spring. The damage usually is slight, mostly mild root necrosis or slight stunting; or sometimes elliptical light-colored eyespots with brown borders occur on the sheaths or culm bases. Under favorable conditions, the fungus may be rather destructive on cereals, causing deep-seated lesions at the ground line, which under stress of wind cause straw-breaking at this point. This condition was noted in one variety of wheat at Mandan in 1943 (Sprague, 663). An exceptionally virulent race of R. solani causes considerable damage in acid soils in the coast region in Oregon (Sprague, 623, 633, 663). The coastal fungus was erroneously assigned to an utterly different fungus by the writer in 1934 (623) although he had, before receiving mislabeled Italian material, properly listed this fungus as R. solani. The Oregon material from the coast is definitely a distinct race, both in its very strong pathological traits and the light, somewhat fluffy type of growth it makes in culture. The Oregon strain or race may be similar to Italian material, in fact the culture which the writer sent to Italy looked very much like the one which was later sent to him from northern Italy. Glynne and Ritchie (268) report similar symptoms on wheat from England and Wales. They believe that Oort's "sharp eye spot" (494) is the same fungus. They mention that Blair, working with some Canadian strains of R. solani, found some that caused stem girdling. They state that sharp eyespot does not increase with the frequency of wheat or barley in the rotations. It is as common in the first wheat crop as it is on old, arable land. The writer has long recognized that this fungus is difficult to control by crop rotation because of its ability to develop on so many hosts. In some places in Oregon cereals have been employed to clean up the soil in preparation for seeding Rhizoctonia-susceptible crops in following seasons. This may not be entirely successful. It is interesting to note that much of the detailed study in recent years on racial differences in R. solani (Houston, 341) has not considered the forms on Gramineae, the most widespread host family.

Hynes describes "purple patch" disease of cereals in Australia due to Rhizoctonia solani (344, 347) wherein small to extensive areas in a field have stunted, stiffened, slightly purplish plants with rotted roots. Dillon Weston and Garrett (171) discuss a similar condition in England and state that the culm is not attacked as has been discussed by Glynne, Sprague, and also Oort as noted above. Samuel and Garrett (574) reported *Rhizoctonia* on cereals in Australia as early as 1932, and Dana (137) mentions it from western Washington in 1919.

Foëx and Rosella (235) described *Sclerotium constantini* Foëx and Rosella on wheat, which is the same as the stem-canker-causing strain of *R. solani* (Sprague, 663).

In addition to *R. solani* and its several races, the writer (663) has mentioned other species of this genus that need taxonomic study.

Brown patch is a case of an attack by *Rhizoctonia solani* in a crowded host colony wherein the fungus is able to spread from a central point, leaving dead brown areas of grass. Brown patch is important in lawns in Minnesota and in the coast region of Oregon and Washington, as well as elsewhere. In Oregon, *R. solani* is a common leaf rot of a large number of species of grasses during the humid winter months. It was a serious pest in spray chamber inoculation experiments at Corvallis during the years the writer was studying *Septoria* leaf spots of grasses. It was particularly destructive to leaves of *Holcus lanatus*, *Agrostis alba*, *A. tenuis*, *A. palustris*, and barley.

References: Bertus (44); Blair (51, 52); Dana (137); Dickinson (158); Dillon Weston and Garrett (171); Foëx and Rosella (235); Garrett (257); Glynne and Ritchie (268); Hearn (320); Hynes (344, 347); Jaarsveld (358); Matz (442); Oort (494); Peltier (508); Peyronel (515); Rogers (538); Ryker (553); Samuel and Garrett (574); Sanford (577); Shaw and Ajrekar (602); Sprague (623, 633, 645, 663); Voorhees (747).

SCLEROTIUM RHIZODES Auers.

Most of the western material originally assigned to *Sclerotium rhizodes* (Hungerford, 343) or to *S. fulvum* Fr. (Young, 777) has been shown to belong to *Typhula* spp. (Remsberg, 532, 533). One specimen on leaves of *Agrostis alba* collected in the Yellowstone National Park, Wyoming, in 1941 by Fischer may be left in *S. rhizodes* for the present. The sclerotia were black, differing from the tawny to hazel brown sclerotia of *Typhula itoana* Imai and the small chestnut brown ones of *T. idahoensis*. In a footnote to one of her articles, Remsberg (532) states that H. H. Whetzel lists, in unpublished data, *S. rhizodes* under *Rhizoctonia*.

References: Hungerford (343); Kreitlow (391); Remsberg (532, 533); Stirrup (687); Stout (688, figs. 1-8); Young (777).

TYPHULA SPP., *Snow Molds.*

After many years of confusion, the snow mold of winter cereals in certain areas in Idaho and Montana have been shown to be caused by two species of *Typhula*, *T. itoana* Imai and *T. idahoensis* Remsberg (Remsberg, 532, 533). The fungi develop on over-wintered rosettes of wheat and certain grasses. After the snow has melted the plants are found covered with a moldy white fungous growth and the tissue is filled with small reddish brown (*T. idahoensis*) or dark brown (*T. itoana*) sclerotia. These fungi occur in Idaho (Hungerford, 343; Remsberg, 532, 533) and Montana (Young, 777 *P. idahoensis*), while *T. itoana* is recognized in the eastern United States (Wernham, 761) and Minnesota (Tervet, 703). The writer (656) noted sclerotia similar to *T. idahoensis* on *Bromus tectorum* L. and *B. mollis* L. on High Prairie, Washington. Snow mold material on wheat sent from Badger Mt. near Waterville, Washington, appeared to have a conidial stage that resembled that of *Sclerotinia graminearum* Elen. (Solkina, 618), which is a winter parasite of grain in Russia. Later reports indicate, however, that this fungus is a species of *Typhula*.

Remsberg noted that *T. graminum* Karst. is distinct from the Idaho fungi and that *Sclerotium fulvum* is the same as *T. itoana* and not related to *T. graminum*, as shown by differences in the structure of the sclerotia of each. *T. borealis* Ekstrand, which was incompletely described, is apparently the same as Remsberg's *T. idahoensis*.

References: Ekstrand (201, 202); Heald (315); Hungerford (343); Imai (350, 351); Müller (477); Remsberg (532, 533); Remsberg and Hungerford (534); Solkina (618); Sprague (656); Tervet (703); Volk (746); Wernham (761); Young (777) Young and Morris (778).

NON-SPORULATING BASIDIOMYCETES, *Snow Mold and Root Necrosis.*

Broadfoot and Cormack (73) report a snow mold-like gray fungus on over-wintered grasses, winter wheat, and alfalfa in Alberta. This fungus is very parasitic at low temperatures. They state, "This pathogen grows readily on most nutrient media at temperatures from 0° to 18° C., producing a fluffy, white sterile mycelium. Cardinal temperatures for growth are -4°, 15°, and 26° C. Sclerotia, fruiting bodies, and spores have not been found on the diseased host plants, and many attempts to produce them in culture under varying conditions of temperature, light, moisture, and nutrient media have failed. The characteristic clamp connections of the mycelium and the occasional production of small rudimentary sporophores on culture media indicate that the fungus is a basidiomycete."

Another non-fruiting basidiomycete has been isolated from crested wheatgrass (*Agropyron cristatum*) in Minnesota by Andrews (15), and from

A. sibiricum, A. elongatum (Host.) Beauv., Elymus canadensis, and crested wheatgrass at Mandan, North Dakota, (Sprague, 663), and on slender wheatgrass (A. trachycaulum) near Medora, North Dakota. It has been isolated also from crested wheatgrass collected near Wibaux, Montana. This fungus is a weak parasite on grasses, causing a slow root necrosis and yellowing of the seedlings. It develops during the summer and fall, as far as it is known at present. It produces a white cottony growth on potato-dextrose agar.

References: Andrews (15); Broadfoot and Cormack (73); Sprague (663).

FUNGI IMPERFECTI

Because there are so many species of Fungi Imperfecti on Gramineae and because some of them have such extensive host ranges, the entire group represents a very complex problem, considered from the viewpoint of the plant pathologist as well as the mycologist. It will be obvious to the reader that considerable fundamental work needs to be done with this heterogeneous group.

In order to bring related fungus genera together, the following grouping is followed:

A Spores borne in pycnidia-----(1) Sphaeropsidales, p. 120

AA Spores borne in acervuli-----(2) Melanconiales, p. 168

AAA Spores borne otherwise-------(3) Moniliales, p. 172

1. SPHAEROPSIDALES

ASCOCHYTA SPP., Leaf Spots.

The writer and A. G. Johnson have prepared but not yet published (674) a taxonomic study of the species of Ascochyta that occur on Gramineae in the western region. It appears desirable to submit the key to these forms, which will appear in a later publication. Ascochyta is considered here as including species with hyaline spores and also those with yellow spores (Ascochytula and Ascochytella), as well as certain species previously assigned to Diplodina, which genus is not distinct from Ascochyta (see also Diedicke, 166).

The characters principally used in segregating the fungi studied in this report are included in the following key:

A. Spores finally yellow or yellow-brown, pycnidia dark............ Sect. *Ascochytula*

B. Spores definitely fusoid, ends somewhat pointed; strongly yellow-brown, 18-27 x 5-7.7 µ. On *Hordeum vulgare* and *Holcus lanatus* .... *Ascochyta* sp.

BB. Spores irregularly cylindrical, sometimes 2-septate, 17-26 x 6.2-7 µ, tardily yellow. On *Avena*........................... *Ascochytella avenae* Petr.

BBB. Spores sub-cylindric, ends rounded, 14-19 x 4.5-6.2 µ in summer material (larger in type). On *Agropyron* and *Elymus* .... *Ascochyta agropyrina* (Fairm.) Trott.

AA. Spores hyaline or only chlorinous, rarely yellow, pycnidia brown

B. Spores sometimes over 4.2 µ in diameter

C. Spores very broad, as much as 8 µ diameter

D. Pycnidia 80-120 µ, spores ovate fusoid, ends acute, 15-19 x 6-8 µ. On *Panicum virgatum* L. .... *Ascochyta* sp.

DD. Pycnidia 190-200 µ, spores sub-cylindric, ends obtuse, 16-23 x 6.5-9 µ

E. Spores 16-19 x 5-7 µ. On *Sporobolus airoides* (Torr.) Torr. .... *A. stipae* Died.

EE. Spores 17-23 x 6.5-9 µ. On *Stipa* sp. .... A. *stipae* Died.

CC. Spores 6-7 µ wide .... *A. boutelouae* Fairm.

CCC. Spores (in our material) typically less than 6.5 µ broad

D. Spores short cylindric or ovate, 11-18 x 3.5-5 µ. On *Distichlis* .... *Diplodina graminea* Sacc.

DD. Spores cylindric or oblong, 16-23 x 4-5.3 µ. On *Festuca*, *Phalaris*, *Pleuropogon*, *Stipa*, etc. .... *A. graminicola* var. *brachypodii* Trail

DDD. Spores spindleform, ends acute, 17-21 x 4.2-5µ, finally subcylindric. On *Andropogon* and *Sorghastrum* .... *A. graminicola* var. *brachypodii* Trail

BB. Spores seldom exceeding 4 µ in diameter

C. Spores 11-20 x 2.5-4 µ, scarcely narrowly cylindrical

D. Spots pale brown or with red borders, usually scattered

E. Spores mostly 11-16 x 2.5-4 µ

F. Spores 11-16 x 2.5-4 µ, ovate or subcylindric .... *A. graminicola* Sacc.

FF. Spores 11-13 x 3.2-3.9 µ, short cylindric .... *A. sorghi* Sacc.

EE. Spores typically longer, cylindrical, 14-20 x 2.5-4 µ .... *A. graminicola* var. *holci* Sacc.

DD. Spots chocolate brown, often numerous, spores cylindrical and similar to *A. graminicola* var. *holci* or shorter, but pycnidia larger. On *Bromus* spp. .... *A. graminicola* var. *diedickeana* Baudyš and Picb.

CC. Spores 11-24 x 1.5-3.0 µ, narrowly cylindrical to sublanceolate

D. Spores sometimes sublanceolate, typically with 1-2 small oil drops adjacent to the cross wall, 12-24 x 2-2.8 µ, in pale spots on *Poa* spp. .... one-septate phase of *Septoria oudemansii* Sacc.

DD. Spores typically cylindrical

E. In brown lesions, spores 11-18 x 2.4-3.1 µ ...... *A. desmazieri* Cav.

EE. In paler lesions, spores 11-18 x 1.5-3 µ in very pale brown thin-wall pycnidia .... *A. elymi* Tehon and Daniels

EEE. In tawny spots in brown pycnidia, spores very narrow, 11-16 x 1.5-2.2 µ. On *Phleum pratense* L. .... *Ascochyta* sp.

ASCOCHYTA sp. on *Hordeum* and *Holcus*, *Leaf Spot* and *Leaf Rot*.

Over-wintered leaves of barley and velvet grass (*Holcus lanatus*) in

Klickitat County, Washington, show pale gray emarginate spots with prominent black pycnidia. The spores are light brown, fusoid-cylindric, often pointed at both ends, 18-24 x 5-6.8 µ, and have coarse granular contents. It is fairly common on High Prairie, Washington, but does not appear to be of very much importance (Sprague and Johnson, 674). It appears in the spring of the year just after the snow has left the rosettes of the over-wintering plants. What appears to be the same species occurs on Agropyron smithii in North Dakota.

ASCOCHYTA sp. on Panicum, Leaf Rot.

Our material of this fungus consists only of a fragment on frost-injured leaves of Panicum virgatum L. and on P. dichotomiflorum Michx. from North Dakota. The spores are short, thick, lemon-shape with sharp ends and slight constriction at the septum. It is probably saprophytic or very weakly parasitic (Sprague and A. G. Johnson 674).

ASCOCHYTA sp. on Phleum pratense L.

This fungus occurs on leaves of timothy in a swamp near Niawa, Minnesota. The tawny leaf spots contain brown pycnidia with very narrow spores 11-16 x 1.5-2.2 µ.

References: Sprague and A. G. Johnson (674); Sprague (668).

ASCOCHYTA AGROPYRINA (Fairm.) Trott., Leaf Spots.
(Ascochytula agropyrina Fairm.)

This very weak parasite or saprophyte has yellowish-brown spores that would place it in Ascochytula, but Trotter (Saccardo, 558, V. 25) places this genus as a sub-genus in Ascochyta which appears to be logical. A. agropyrina is widely scattered and common but never occurs in great abundance in any material. It has been found on Agropyron bakeri E. Nels. in New Mexico (Fairman, 222); on A. caninum (L.) Beauv. (from Russian seed), A. cristatum, A. michnoi Roshev, A. semicostatum (Steud.) Nees, A. subsecundum (Lk.) Hitchc., A. trachycaulum, A. trichophorum (Lk.) Richt., Elymus canadensis, and E. virginicus in North Dakota; A. cristatum and A. smithii in Montana; and on A. semicostatum from Pullman, Washington. The material from Pullman has fuscous spots with red to vinaceous borders but the spores are pale yellow and with the stout cylindrical shape of A. agropyrina.

References. Fairman (222); Saccardo (558) v.25; Sprague and A. G. Johnson (674); Trotter (713).

ASCOCHYTA BOUTELOUAE Fairm., *Leaf Mold.*

Scarcely parasitic, a relatively common fungus on the leaves of blue grama in central North Dakota and in New Mexico. The spores in this species are thicker than those of *A. graminicola*, somewhat near *A. graminicola brachypodii* but the black, often sub-superficial (saprophytic), tardily ostiolate pycnidia, together with a hint of smokiness in the spores, distinguish *A. boutelouae* from *A. graminicola* var. *brachypodii* (Sprague and A. G. Johnson, 674). *A. boutelouae* is scarcely distinguishable morphologically from *Diplodina graminea* Sacc. (Sprague and A. G. Johnson, 674). Fairman (222) described this from New Mexico.

ASCOCHYTA DESMAZIERI Cav., *Leaf Blotch.*
(*Septoria lolii* West. and *Diplodina lolii* Zimm.)

The fungus causes a brown or brownish purple spot on the leaves of *Lolium perenne* L. and *L. multiflorum* in Oregon, Washington, and California. It is sometimes destructive. The spores are truly cylindrical and readily distinguished from those of the *A. graminicola* complex. Its symptoms are readily distinguished from the speckled gray blotch caused by *Septoria tritici* var. *lolicola* Sprague and A. G. Johnson (665), but can be confused with those of *S. loligena* Sprague. It should, in fact, be compared critically with this fungus.

References: Cavara (99); Sprague (655; 665); Sprague and A. G. Johnson (674); Zimmerman (781, (p. 101).

ASCOCHYTA ELYMI Tehon and Daniels, *Leaf Spot.*

Tehon and Daniels (701) distinguish this species from *A. graminicola* by its fragile pycnidia as contrasted with the brown ones of *A. graminicola*. The writer has found *A. elymi* on seedlings of *Elymus canadensis* near Solen, North Dakota. Traces of it occur on *Elymus* spp. in the Rocky Mountains and possibly on *Agropyron repens* near Eugene, Oregon.

ASCOCHYTA GRAMINICOLA Sacc. and Varieties, *Leaf Spots.*

Davis' summary of the common parasite, *A. graminicola*, is generally accepted (Davis, 140). While the fungus usually is limited to a few red-bordered brown or fawn-colored spots on the lower leaves or leaf tips, the fungus is sometimes aggressively parasitic. Such material has been seen on *Hierochloë odorata* (L.) Beauv. in North Dakota and South Dakota. In the far west it is common or more often scattered on a number of grasses during the rainy season in winter and spring, while east of the Rockies it develops during rainy periods in the summer

(Sprague, 655, 656).

Some 14 varieties have been described for *A. graminicola*, but these include some "varieties" which are readily referable to *Darluca filum* (Biv.) Cast. In fact, it is conservative to say that a majority of the specimens in herbaria that are assigned to *A. graminicola* are *D. filum* or sometimes immature stages of *Hendersonia*, *Stagonospora*, or *Septoria*. Among the recognizable varieties of *A. graminicola*, var. *holci* is considered to have somewhat larger spores than true *A. graminicola* and much of our western material would fall under this variety if it is recognized. A more obvious form, var. *brachypodii* Trail (708), occurs on *Phalaris arundinacea* L. at Mandan, North Dakota; on *Lolium perenne* L. from Troutdale, Oregon, on *Stipa comata* Trin. and Rupr. in Montana, on *Andropogon furcatus* Muhl, at Mandan, North Dakota, and on *Pleuropogon refractus* (A. Gray) Benth. in Oregon (Sprague and Johnson 674). These all tend to have fusoid spores, 15-17 x 5 µ, while the species proper and var. *holci* have narrower spores that are nearly cylindrical, 10-20 x 2.5-4 µ.

Var. *diedickeana* Baudyš and Picb. (26) produces brown-bordered lesions with paler centers, and in severe cases dark brown or nearly black general scalding of affected green parts. It occurs on *Bromus carinatus* in Oregon, on leaves of *B. inermis* in Minnesota, and on roots of *B. inermis* in North Dakota (see also Broadfoot, 72). It occurs on *Hordeum nodosum* L. at Hunter, Alaska. In addition to its distinct symptoms and parasitic tendencies, this variety is recognizable to some extent by its cylindrical to fusiform spores, 11-17 x 2.5-3.1 µ, which are narrower than those of var. *holci*.

Ascochyta graminicola is indeed a complex, and further life history studies may show that some of these morphologically similar forms are growth stages of entirely different fungi.

References: Baudyš and Picbauer (26); Broadfoot (72); Davis (140); Sprague (655,656); Sprague and A. G. Johnson (674); Trail (708).

ASCOCHYTA SORGHI Sacc., Leaf Spot.

What can be called this fungus was collected on sorghum at Brookings, South Dakota, in 1912 by C. R. Ball and determined by the writer 30 years later. The spores are small and cylindrical, 11-12.5 x 3.2-3.9 µ.

ASCOCHYTA STIPAE Died., Leaf Spot.

A prominent maroon to vinaceous leaf spot occurs on *Stipa* sp. on Mt. Shasta, California. The broad spores are 17.5-24 x 6.5-9 µ. Another collection on *Sporobolus airoides* from Pullman, Washington, has smaller spores but they are similar in shape to those on *Stipa* (Sprague and

Johnson, 674).

ASCOCHYTELLA AVENAE Petr., Leaf Spot.

This fungus which was placed in still another genus (Ascochytella) by Petrak (510, p. 107) belongs in the yellow-spored section or subgenus Ascochytula of Ascochyta. It was found once in late winter on Avena byzantina C. Koch (red oats) near Troutdale, Oregon, and on A. fatua (wild oats) at Pullman, Washington (Sprague and A. G. Johnson, 674).

CONIOTHYRIUM PSAMMAE Oud., Leaf Spot.

Coniothyrium psammae occurs scatteringly along the sea coast in Oregon on Calamagrostis nutkaensis (Presl) Steud. The spots are large, elliptical, light buff with prominent vinaceous borders. The pycnidia are few and contain brown elliptical spores, 10-13 x 3-4 µ.

Reference: Sprague (652).

DILOPHOSPORA ALOPECURI (Fr.) Fr., Twist Disease.

The leaves and more often the heads are attacked. The fungus causes a black, charred-appearing crust accompanied by deformation and twisting of the head and adjacent leaves. Affected heads are frequently killed in the boot. The fungus develops abundant black masses of pycnidia, which produce spores with characteristic bristle-like appendages at both ends. The spores are hyaline, 8-15 x 1.6-2.5 µ; and the appendages are 5 to 7 µ, less often 10 µ long and 0.5 µ thick at the base, 3-4 branched with some branches forked or sometimes tri-furcate.

Atanasoff (18) has detailed a study wherein he suggests that the spores are carried by Tylenchus tritici (Steinb.) Bast. to the growing points of the plant. This appears to be discounted by many writers. Certainly in the Pacific Northwest the twist disease does very well without the assistance of nematodes in most cases.

Some workers, including Rainio, claim that Mastigosporium album Riess and D. alopecuri are part of the same life cycle. This is utterly incorrect (Sampson and Western, 570; Sprague, 640). No proof of connection with Dilophia graminis Sacc. has been obtained in this country either.

Dilophospora alopecuri is common in Oregon and Washington on Holcus lanatus and Sitanion jubatum J. G. Sm. and it occurs on Agropyron inerme in eastern Washington; on A. smithii in Idaho; on A. spicatum in Montana; on A. trachycaulum in Yellowstone Park, Wyoming, and Roosevelt Park, North Dakota, on *Melica bulbosa* Geyer in Yellowstone Park; and on *Poa secunda* at Logan, Utah. Most of the collections have been made recently by Fischer and the writer but the fungus has been present in the West for an indefinite period. Jackson collected it in Oregon in April, 1915 (O.S.C. 10,530). Bessey (45) reported it from Wisconsin in 1906.

Bevilacqua (46) recommends that the wheat be cut high, the stubble burned, and the seed treated.

Reference: Atanasoff (18); Bessey (45); Bevilacqua (46); Grove (296); Kotte (389); Raino (520); Sampson and Western (570); Schaffnit and Wieben (585); Sprague, 640).

DIPLODIA ZEAE (Schw.) Lév., Dry Rot of Corn.

This dry rot of corn ears has been well discussed and illustrated by several workers in Nebraska (Heald et al., 318), Iowa (Durrell, 189), and the eastern States. The fungus also causes sheath and leaf spots and stalk rots, and the fungus in the seed causes seedling blight. The disease is important in Iowa, eastern Nebraska, and Minnesota but disappears in the West although it probably occurs in favored, more humid areas.

References: Bijl (47); Burrill and Barrett (84); Clayton (116); Durrell (189, 190); Eddins and Voorhees (193); Heald (312); Heald et al. (318); Hoadley (332); Holbert et al. (336); Holbert, Hoppe, and Smith (337); Hoppe (338); Kent (381); Kinsel (382); Koehler and Holbert (388); Larsh (398); McNew (451); Raleigh (521); Semeniuk (590-593); Semeniuk et al. (596, 597); Ullstrup (728); Valleau et al. (735); Wilson (767).

DIPLODINA GRAMINEA Sacc., Leaf Mold.

Material collected by the writer at Davis Junction, California, on *Cynodon dactylon* (L.) Pers. shows sub-superficial pycnidia scattered among *Helminthosporium cynodontis* Marig. The spores of the *Ascochyta* are capsular, one-septate, clear hyaline but with a hint of smokiness in mass, 11-18 x 3.9-5 µ (Sprague and Johnson, 674). Diehl (169) reported the fungus from South Carolina in 1935, the first report for the western hemisphere. The fungus is probably common. Nothing is known as to its pathogenicity. See also *A. cynodontis* Unam. (730).

HENDERSONIA SPP., Molds.

Some of the common invaders of dead or dying tissue are species of *Hendersonia* Berk. em. Sacc. Therefore, in routine examination of diseased plants, workers are confronted with scattered pycnidia belonging to species of this genus. The brown spores of Hendersonia are broadened, not filiform nor elongate-vermiform as in some species of Phaeoseptoria (Sprague, 659). Since this group does not contain any species that are definitely parasitic it is not considered necessary to discuss them in detail. In addition the taxonomy of this group is in great confusion, at least from the viewpoint of literature available on the western forms. The writer has an uncompleted manuscript dealing with about 16 species in the Western States (667). They are particularly common on overwintering grasses in the Pacific Northwest and Rocky Mountain areas and on grass in the late fall in the Northern Great Plains.

Among the common species of Hendersonia are H. simplex Schroet., H. culmicola Sacc., H. crastophila Sacc., H. calamovilfae Petr., H. stipae-pennatae Fautr., and H. calospora Fautr. Several less common or undescribed species also occur.

The following is a simplified key to these species:

A. Spores when mature typically 7-septate.

  B. Pycnidia very large, 180-300 µ in diameter

    C. Spores falcate or falcate-fusiform, 28-40 x 3.8-4.4 µ .... Wojnowicia graminis

    CC. Spores fusiform, vermiform, coarse, somewhat constricted at the septa, 35-53 x 3.5-5 µ ...... H. calospora Fautr.

  BB. Pycnidia smaller, 80-220 µ in diameter

    C. Spores regularly cylindrical, ends blunt, cross walls closely adjacent, 20-29 x 4-6 µ .... H. stipae-pennatae Fautr.

    CC. Spores more or less fusiform, sub-cylindrical; ends or at least one end somewhat to definitely tapered; septa not particularly closely adjacent

      D. Spores as much as 7 µ wide ... H. calamovilfae Petr.

      DD. Spores mostly 3-5 µ wide

        E. Spores brown, fusiform or falcate, flattened on one side, constricted at the septa

          F. Spores fusiform, pycnidia rarely with hairs on the ostiolar end .... H. crastophila Sacc.

FF. Spores fusiform-falcate or falcate, pycnidia with scattered hairs on the ostiolar end ..... *Wojnowicia graminis* (McAlp.) Sacc. and D. Sacc. (Confusable with *H. crastophila* when immature)

EE. Spores lighter colored, small paired regularly placed prominent guttulae, often constricted at septa, sub-cylindrical, ends conical, not stiffly flattened on one end .... *Hendersonia* sp.

EEE. Spores shorter than in EE, rarely constricted at septa, more often 5- than 7-septate .... *H. culmicola* Sacc.

AA. Spores when mature typically 5-septate or less (see also *H. culmicola* above)

B. Spores sometimes more than 3-septate, cylindrical

C. Spores 3-, 5-, to 7-septate, 30-38 x 3.1-4.2 µ.......... *H. culmicola* Sacc.

CC. Spores 3- to 4-septate, 20-27 x 3.2-3.4 µ .... *H. culmicola* var. *intermedia* Sacc.

BB. Spores not more than 3-septate

C. Spores with stout epispores, 6.2-7.8 µ wide .... *Hendersonia* sp.

CC. Spores with thin walls, less than 5 µ wide

D. Spores 28-48 x 3.8-4.3 µ .... *Hendersonia* sp.

DD. Spores less than 30 µ long or approximately that

E. Spores short-cylindrical, some at least 4 µ wide

F. Spores 22-29 x 2.8-4.6 µ .... *H. agropyri-repentis* Oud.

FF. Spores 15-20 x 4.3-4.8 µ .... *Hendersonia* sp. on *Danthonia intermedia* Vasey

EE. Spores sub-cylindric to fusiform, not over 3-5 µ wide

F. Spores often 1-septate, finally 3-septate, sublanceolate at first, 17-22 x 2-2.6 µ........ *H. culmicola* var. *minor* Sacc.

FF. Spores mostly 3-septate, sub-bacillar, 14-26
x 2.3-3.1 μ .... *H. simplex.* Schroet.

The closely related species *Wojnowicia graminis* is included in the key for comparison.

References: Grove (297); Saccardo (558, v. 3, 10, 11, 12, 13, 14, 16, 18, 22, 25); Sprague (667).

MACROPHOMA PHLEI Tehon and Stout, *Leaf Mold.*

What was probably saprophytic material of *M. phlei* was seen at Mandan, North Dakota, on *Elymus triticoides* Buckl. on October 1, 1943 (B.P.I. 80,893). Spots were diffuse straw-color, or more often absent. The pycnidia were black, depressed, globose, 120-135 x 120-204 μ bearing elliptical to elongate ovate spores, which were slightly larger at one end, with pure white opaque contents, 28-39 x 8.5-11.1 μ, mean size 32 x 9.4 u. This compares with 18-26 x 6.4-7.7 μ for the type of *M. phlei*, which indicates that the Mandan material has somewhat larger spores but is probably the same species. *M. phlei* has also been seen on *Agrostis palustris* from Waldport, Oregon, with spores 24-31 x 9.5-11 μ.

References: Sprague (666); Tehon and Stout (702, p. 188).

MACROPHOMINA PHASEOLI (Maubl.) Ashby, *Charcoal Rot.*
(*Sclerotium bataticola* Taub.)

Charcoal rot develops in the stalks of corn and sorghum in late season, causing general decay and weakness with the resultant breaking over of diseased plants. The numerous small black bodies form in large numbers. These are said to be prosenchymatous-filled pycnidia or sclerotium-like bodies of the Sphaeropsidaceous *Macrophomina phaseoli*. *M. phaseoli* occurs on corn in California (Mackie, 426) and recently has been given considerable publicity in Nebraska (Livingston, 409, 410), Iowa (Semeniuk, 594) and adjacent states. It has not been isolated, as yet, from North Dakota material, although a sclerotial form superficially resembling it has been obtained from roots of several grass crops at Mandan.

References: Ashby (17); Dunlap (188); Haigh (304); Hoffmaster et al. (334); Livingston (409, 410); Schwarze (587, p. 148-149); Semeniuk (594, 595); Taubenhaus (699); Tehon and Boewe (700); Uppal et al. (733).

PHAEOSEPTORIA Spp., *Leaf Molds and Secondary Invaders.*

Species of this genus sometimes are encountered on dead or dying leaf and culm tissue of grasses. *Phaeoseptoria* belongs to the Scolecosporae, has coarse black pycnidia and light brown multiseptate spores. A key to all known forms of this genus on grasses and a discussion of their taxonomy has recently appeared (Sprague, 659) and it seems unnecessary to repeat this information here as the group is of little economic importance.

PHOMA SP.

An undetermined species of Phoma was reported as important on Agropyron smithii Rydb. in Utah by O'Gara (493).

PHOMA TERRESTRIS Hansen, Pink Root.

The same fungus that attacks the roots of onions, causing pink root, is able to attack the roots of cereals and grasses (Kreutzer, 392). Johann (365) and Sprague (662) verified this and also isolated the fungus from Gramineae. It occurs in many species of grasses and cereals in the Northern Great Plains but is not very parasitic.

P. terrestris causes a pink to carmine-lake coloration of the roots. It sometimes causes mild seed rot and slight rootrot. In culture, it produces a slow-growing mounded gray colony with pink to magenta tints in the substrate. It does not fruit readily on potato-dextrose agar.

References: Carvajal (96); Johann (365); Kreutzer (392); O'Gara (493); Sprague (662).

PHYLLOSTICTA

Five species of Phyllosticta, not known to be phases of more complex fungi, may be distinguished by the following key:

A. Pycnidia in spots with pale centers

  B. Spots small, white, spores 11-15 x 2.5-4.5 µ .... P. rogleri Sprague

  BB. Spots irregular, pale to discolored, with red to purple borders, spores 4-7 x 2-3 µ .... P. sorghina Sacc.

AA. Pycnidia in gray or vague spots

  B. Spots gray, elongate, spores bacillar, 2.3-4.6 x 1-1.4 µ.... P. owensii Sprague

BB. Spots vague on dead leaves, spores bacillar, 5-9 x 1-1.6 µ .... *P. anthoxella* Sprague

BBB. Spots cream color to pale yellow, emarginate, spores oval to elliptic, 6.5-8 x 3-4 µ.....*P. avenophila* Tehon and Daniels[5]

PHYLLOSTICTA ANTHOXELLA Sprague, *Leaf Spot*.

The small black pycnidia are scattered over moldy dry leaves of *Anthoxanthum odoratum* L. collected at Triangle Lake, Oregon (Sprague, 652, fig. 1, *e*). Little is known about this fungus, which appears to be of slight importance.

PHYLLOSTICTA OWENSII Sprague, *Gray Leaf Streak*.

Also a minor parasite or mold on living, dead or salt-spray injured leaves of *Dactylis glomerata* in the vicinity of Waldport, Oregon (Sprague, 652). It is an associate of *Scolecotrichum graminis* Fckl.

PHYLLOSTICTA ROGLERI Sprague, *White Leaf Spot*.

Known only on *Digitaria sanguinalis* (L.) Scop. from Albia, Iowa. (Sprague, 652, fig. 1, *f*).

PHYLLOSTICTA SORGHINA Sacc., *Eyespot*.
(*Phoma insidiosa* Tassi)

The lesions are irregular to sub-circular, pale straw to isabelline color spots with narrow purple to red borders, 3-8 mm in diameter. They develop during the summer rainy season and are associated with various bacterial and possibly non-parasitic spots on *Setaria viridis* in North Dakota (Sprague, 652, fig. 1, *g*).

SELENOPHOMA

The genus *Selenophoma* is characterized by pycnidia with non-septate, sickle shape (falcate), hyaline spores (Maire, 428).

Key to the species:

A. Spores acute, boomerang or arcuate

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[5] This fungus occurs in Illinois and Mississippi but is likely to be found in the area covered in this report.

B. Spores arcuate, typically 10-16 x 1.1-1.8 µ..................
S. everhartii (Sacc. and Syd.) Sprague and A. G. Johnson

BB. Spores lunate to boomerang, typically 18-30 x 2-4 µ ....
S. donacis (Pass.) Sprague and A. G. Johnson

BBB. Spores lunate to sub-arcuate, typically 12-24 x 1.5-2.7 µ ...
S. donacis var. stomaticola (Baüml.) Sprague and A.G. Johnson

BBBB. Spores lunate, 17-25 x 2-3.2 µ. On Bromus ....
S. bromigena (Sacc.) Sprague and A. G. Johnson

AA. Spores obtuse, sub-reniform-falcate ....
S. obtusa Sprague and A. G. Johnson

SELENOPHOMA BROMIGENA (Sacc.) Sprague and A. G. Johnson

The common host, Bromus inermis, is severely damaged by this fungus which forms gray, irregular to sub-circular spots on the leaves in early spring. It is especially prevalent in the Red River valley and in Minnesota but occurs westward to Pullman, Washington. It is not uncommon on the prairies in Idaho but has not yet been noted in Oregon or California. It appears to be rather largely confined to B. inermis growing in the plains countries. It occurs in Hungary (Krypt. Exs. Palatino, No. 1465) but has not been given much recognition outside the United States.

Selenophoma bromigena differs from S. donacis somewhat vaguely in that the spores of S. bromigena are regularly lunate, sharp-pointed, rarely boomerang shape. An undated packet of a fungus called Phlyctaena bromi by Clements (Crypt. F. Coloradensium) on Bromus ciliatus L. appears to be a saprophytic phase of S. bromigena on an unusual host. Allison (9) found that S. bromigena was confined to B. inermis. Field observations show that there are very few exceptions to this. S. bromigena has been collected in trace quantities on B. carinatus at Glenrock, Wyoming, Pullman, Washington, and Mandan, North Dakota.

References: Allison (8-10); Darley (138); Saccardo (557); Sprague and A. G. Johnson (673, 675, 676).

SELENOPHOMA DONACIS (Pass.) Sprague and A. G. Johnson.
(Septoria oxyspora Penz. and Sacc.)

This fungus is commonly known as Septoria oxyspora, less often as Septoria donacis Pass., an earlier name. While it was described on Arundo donax L., a giant reed, it occurs also on Phalaris arundinacea in Washington and North Dakota; rarely on Phragmites communis Trin. in

North Dakota; (*Septoria curva* Karst.) on *Elymus condensatus* Presl in Washington, North Dakota, and Oregon; on *E. flavescens* Scribn. and Sm. in Washington; on *Panicum virgatum* in the Great Plains; and on *Stipa columbiana* Macoun, *S. comata*, *S. richardsoni* Lk., *S. spartea* Trin., and *S. viridula* in the Great Plains and westward.

Selenophoma donacis on *Arundo*, *Phalaris*, and *Elymus* has spores averaging around 20-21 x 3 µ and more or less boomerang shape. Spores of *S. donacis* on *Panicum* are the same length as those on *Arundo* but are recognizable because of their narrower shape. They are 21.5 x 2.2 µ, mean size, in one collection. Those on *Stipa* are stubbier, 18.3 x 2.8 µ, average, and the material on *Phragmites* has thicker, short spores, 16-18 x 3-4 µ but typically boomerang shape.

Most of the lesions are straw color with tawny, fuscous, or lilac tinted borders, and contain small obscure pycnidia. Very often the spots fade, leaving the pycnidia in unspotted tissue on the culms, sheaths or leaves.

S. donacis has not been studied so thoroughly as its variety *stomaticola*, and therefore cannot be segregated into races. On cultural characters, it is indicated that there is a distinct race on *Elymus flavescens* from the sandhills near Hanford, Washington; one on *Arundo* from California; and probably the same race on *Phalaris* in the northern United States; another on *Panicum*; and probably two on *Stipa*. The culture from *E. flavescens* from Hanford, Washington, for instance, produces an ivory color growth quite different from the congo pink to testaceous rose mycelia from California material of *Arundo donax*. However, a race with narrower spores isolated from *Panicum virgatum* from material collected at Coburn, North Dakota, was very similar to the culture from *Arundo* (Sprague and A. G. Johnson, 675). Until there is more evidence to the contrary, all of these groups are placed under one species because the morphological differences between them are not fundamental.

References: Grove (296); Passerini (504); Penzig (509); Sprague and A. G. Johnson (673, 675).

SELENOPHOMA DONACIS var. *STOMATICOLA* (Baüml.) Sprague and A. G. Johnson. (*Phyllosticta stomaticola* Baüml.)

The complex that we place under this variety has, in general, spores that are 3-5 µ shorter than those of the species and are distinctly narrower. The problem is not so simple as that, however, because spores in some groups, such as that on *Agropyron*, approach or equal in size those of *S. donacis* on *Panicum*, while in others, as that on *Sporobolus*, they are close to the small-spored *S. everhartii* (Sacc. and Syd.) Sprague and A. G. Johnson. One group on *Poa* (cfr. *Septoria nebulosa* Rostr.) has short spores with sharper tips, while material on

Danthonia has evenly lunate spores with softly tipped ends. It is, nevertheless, difficult to segregate these groups into species on any satisfactory basis. Because of our present incomplete knowledge, it appears more practical to assign all of them to the earliest available name as a variety under S. donacis.

The symptoms induced by this variety are of two kinds, light color spots with pale, tawny, red or lilac borders, or no spots at all with the minute pycnidia scattered over straw-color areas. On Calamovilfa, in the Dakotas, the spots are particularly pale, while on Danthonia californica Bol. in Oregon, the spots are a "frog eye" type with a prominent red or maroon border. The lesions on rye (Secale cereale L.) are fuscous to straw color without prominent borders while the pycnidia are more prominent against the light background than on most other hosts.

Pure culture studies, plus examination of a large number of collections on western grasses, have shown that var. stomaticola is divisible into 11 major groups or major races as follows:

Race 1, on Danthonia californica, is closest to Septoria lunata Grove (296) with the regularly lunate spores with soft-pointed tips. It produces a light gray crustose colony with scant mycelium and opalescent grayish white spore droplets. The medium was tinted rosy-vinaceous. The fungus is restricted to this species of host.

Race 2, on Dactylis glomerata and Koeleria cristata from Pullman, Washington. The isolates from these two hosts are identical, each produces a lavender-tinted colony.

Race 3, on Festuca idahoensis from Lyle, Washington, has the appearance of race 2 in pure culture but the spores are narrower and resemble those of the next race.

Race 4, on Agropyron and Elymus spp. has spores that average slightly narrower and longer than those on most other hosts of this variety and they form a definite group.

Race 5, on Poa spp. The native species of Poa from the middle Columbia River Valley harbor a race that is similar in pure culture to race 2, but not identical with it, and with spores that are thicker in their middle portions and sharper at their ends.

Race 6, on Poa spp. from Pullman, Washington, and the Big Horn Mountains, Wyoming, tends to form cream color, soon tan, brown, creosote, and finally black colonies. These seem to represent a distinct group.

Race 7, on Poa pratensis from Quad Creek, Montana, is akin to race 6 but the burnt-orange, later brown colonies plus somewhat boomerang shape spores indicate that this is at least a localized variant. Races 5 to 7 are similar to *Rhabdospora groenlandica* Lind (407), particularly race 7 from the sub-alpine Rockies.

Race 8, on *Arrhenatherum elatius* (type host of *Phyllosticta stomaticola*) from Bozeman, Montana, differs from race 2 in lesser tendency to form lavender color in agar, and in the production of dirty tan, mucose conidial masses in early stages of growth. It is close to race 6.

Race 9, on *Phleum pratense*, is distinct from race 1 in host range but its relation to the others is undetermined. This fungus was described by Lind (406) as *Septoria culmifida* Lind. However, it is morphologically indistinguishable from most of the *S. donacis stomaticola* complex.

Race 10, on *Sporobulus asper* (Michx.) Kunth, has not been cultured and little is known of its relationship with the other races. Since it has some boomerang-shape spores it somewhat resembles *S. donacis* but the spores are narrower.

Race 11, on rye (*Secale cereale*), also needs study as soon as viable material is available. The pycnidia are prominent but not large, 95-111 x 72-85 µ, and the spores are 12-18 x 2-3.5 µ, mean size 14.5 x 2.4 µ, in one collection, 16 x 2.7 µ in another. This fungus has been found in an area north of Jamestown, North Dakota, and also in Minnesota. The symptoms may be confused with those caused by bacterial leaf blight and therefore the disease on rye may be more widespread than is known at the present. It has no relation to *Septoria falcispora* Demidova (148) (non Bubák).

Selenophoma donacis var. *stomaticola* has the following host range in the various States: *Agropyron albicans* Scribn. and Sm. (N. Dak.); *A. dasystachyum* (Hook.) Scribn. (Oreg.); *A. repens* (Wash., N. Dak.); *A. riparium* Scribn. and Sm. (N. Dak.); *A. smithii* (N. Dak., S. Dak., Mont., Wyo.); *A. spicatum* (N. Dak., Wyo., Wash.); *A. subsecundum* (Mont.); *A. trachycaulum* (Mont., N. Dak.); *Arrhenatherum elatius* (Mont.); *Calamovilfa longifolia* (Hook.) Scribn. (N. Dak., S. Dak.); *Dactylis glomerata* (Oreg., Idaho, Wash.); *Danthonia californica* (Oreg.); *Elymus canadensis* (N. Dak.); *E. giganteus* Vahl (Wash.); *E. glaucus* (Wash., Oreg.); *E. junceus* Fisch. (N. Dak.); *E. virginicus* (N. Dak.); *Festuca idahoensis* (Wash.); *F. ovina* L. (Wash.); *Hordeum brevisubulatum* (Trin.) Lk. (N. Dak.); *H. vulgare* (Oreg.); *Koeleria cristata* (N. Dak., Wyo., S. Dak., Mont., Wash., Idaho); *Melica harfordii* Boland (Calif.); *Oryzopsis hymenoides* (Roem. and Schult.) Ricker (N. Dak., Mont., Calif., Oreg.); *Phleum pratense* (Alaska, N. Dak.); *Poa alpina* L. (Mont.); *P. ampla* Merr. (Wash., Mont., Oreg.); *P. arctica* R. Br. (Mont.); *P. compressa*

(N. Dak.); *P. epilis* Scribn. (Wyo.); *P. interior* Rydb. (Mont.); *P. juncifolia* (Oreg., Wash.); *P. nervosa* (Hook.) Vasey (Mont., Wyo.); *P. pratensis* (Mont., N. Dak., Wyo., Wash.); *P. secunda* (N. Dak., Wyo., Mont.); *Puccinellia nuttalliana* (Schult.) Hitchc. (N. Dak.); *Secale cereale* (N. Dak., Minn.); *Sitanion hystrix* (Nutt.) J. G. Sm. (Wash., Oreg.); *Sporobolus asper* (N. Dak., Mont., Iowa); *S. cryptandrus* (N. Dak.).

Some of these have not been given racial classification as little is known about them. The entire problem is a tremendous one, but since members of the group, with a few exceptions, are minor parasites, the need for study is not pressing. The group is almost unknown to plant pathologists although extremely common. Very often the small spherical pycnidia (frequently only 40 µ in diameter) contain but few spores, which are not easily crushed out of the pycnidia. These scattered spores when seen floating free in the mount may be easily mistaken for spores of *Colletotrichum*.

References: Baümler (27); Bisby et al. (49); Bubák (77); Demidova (143); Grove (296); Lind (406, 407); Lobik (411); Petrak (511); Rostrup (545); Sprague and A. G. Johnson (673, 674, 676).

SELENOPHOMA EVERHARTII (Sacc. and Syd.) Sprague and A. G. Johnson. (*Septoria everhartii* Sacc. and Syd.)

The pycnospores of this species are smaller than those of *S. donacis* var. *stomaticola* and in most of the material are more arcuate, being beautifully crescent-shape with sharp points. There is reason for assigning this species to the *S. donacis* complex because all sizes of spores are found on the various hosts from the large ones of *S. donacis* on *Arundo* to the small ones on *Agrostis*. In final analysis, it has been decided to separate *S. everhartii* from var. *stomaticola*, although most of our herbarium material was originally assigned to *S. donacis*. Sprague and A. G. Johnson (675) concluded that the *S. donacis* complex was sufficiently confusing without adding the small-spored group to it (676). The spores are 11-15 x 1.1-1.3 µ, sometimes 10-20 x 1-2.4 µ.

The symptoms caused by *S. everhartii* are similar to those produced by *S. donacis*. On *Calamagrostis canadensis* (Michx.) Beauv. the lesions are elongate, white with vinaceous to vague borders. Much of the material on *Agrostis* and on alpine material in semi-arid regions in general is obscure, with minute pycnidia on stramineous, dead plants. On *Aristida* and on *Bouteloua curtipendula* (Michx.) Torr. gray to tawny or paler, eye-spot lesions with vinaceous borders occur, often intermingled with saprophytic material from the preceding year.

In pure cultures on potato dextrose agar, *S. everhartii* shows as much racial variation as *S. donacis* var. *stomaticola*. Thus, an isolate from *Agrostis scabra* Willd. (Ft. Totten, North Dakota) has gray and rose colored leathery mycelia with lavender color in the substratum. From *Trisetum spicatum* (L.) Richt. (Beartooth Pass, Montana), the mycelium is gray and creosote color over pale lavender; while on agar an isolate from *Bouteloua curtipendula* (western, North Dakota) produces a crustose off-white mycelium with no substratum color, very different in appearance from the others. A culture from *Deschampsia atropurpurea* (Wahl.) Scheele (also at Beartooth Pass, in Wyoming) is similar to that from *T. spicatum* but with gray and isabelline mycelium. On *D. danthonioides* (Trin.) Munro (Pullman, Washington), the mycelium was burnt-orange mixed with pink and black and with an orange substratum color, quite different from any of the others. A recent isolate from *Muhlenbergia racemosa* (Michx.) B. S. P. (Mandan, North Dakota) formed a black carbonaceous growth. This isolate when incubated on sterilized brome stems over winter produced small black perithecia (80-90 µ) belonging to the Mycosphaerellaceae. A few contained fascicled asci containing 8 ellipsoidal ascospores 7-9 x 2-2.6 µ. Unfortunately, it could not be determined whether these were slightly immature and only bi-guttulate (*Ascospora*) or somewhat more immature and ultimately one-septate (*Mycosphaerella*); nor could the spores be germinated.

Selenophoma everhartii occurs on the following hosts: *Agrostis diegoensis* Vasey (Calif.); *A. scabra* (N. Dak.); *Aristida longiseta* Steud. (N. Dak.); *A. oligantha* Michx. (Iowa); *Bouteloua curtipendula* (N. Dak.); *Calamagrostis canadensis* (this is the type host from Wisconsin of *Septoria calamagrostidis* Ell. and Ev. (non (Lib.) Sacc.) from which *Septoria everhartii* Sacc. and Sydow was derived); *C. montanensis* Scribn. (N. Dak.); *C. scribneri* Beal (Wyo.); *Deschampsia atropurpurea* (Wyo., Mont.); *D. caespitosa* (L.) Beauv. (Mont. and Wyo.); *D. danthonioides* (Wash.); *D. elongata* (Hook.) Munro (E. Wash.); *Festuca kingii* (S. Wats.) Cassidy (Mont.); *F. ovina* (Mont. and Wash.); *F. ovina* var. *brachyphylla* (Schult.) Piper (Wyo. Mont.); *F. rubra* (Mont.); *Muhlenbergia cuspidata* (Torr.) Rydb. (N. Dak.); *M. racemosa* (N. Dak.); *Sphenopholis obtusata* (Michx.) Scribn. (N. Dak.); *Trisetum spicatum* (Mont., Wyo.).

Some of the specimens that have been placed in *Selenophoma everhartii* may be immature stages of *S. donacis* var. *stomaticola*, in fact one reason for the long hesitation in assigning these to a separate species was the fact that fungi on *Agrostis* and *Calamagrostis* tend to be smaller on that host than the same species on some other hosts.

Selenophoma everhartii is the most common species on alpine and subalpine plants and is abundant on the dry culms of grasses in the plains country in late summer.

References: Ellis and Everhart (214); Rostrup (545); Saccardo (558); Sprague and A. G. Johnson (675, 676).

SELENOPHOMA OBTUSA Sprague and A. G. Johnson.

This fungus is a variant of the *S. donacis* complex but in most collections it is distinguishable from that group by its short, thick, almost reniform spores averaging 13-17 x 2.5-4 µ. In pure culture it is distinguishable from most of the others by prominent black pycnidial aggregates scattered in salt and pepper pattern over a light isabelline to very pale flesh background. While the spore exudate is pale lavender, the strong rosy tints of *S. donacis* and the vinaceous to lavender ones of var. *stomaticola* are less prominent. In its early stages of growth, an isolate from *Sitanion hystrix*, Mt. Shasta, California, (W. B. Cooke) produced a wet-leathery, faintly flesh color to isabelline colony. A culture isolated from *Agropyron inerme* collected at Washtucna, Washington (G. W. Fischer) showed the same type of growth in early stages, but later, mucose, tan, and still later, brown masses of spores formed over the earlier growth. This case was similar in appearance to race 6 of var. *stomaticola* and this collection may be misassigned. While typical material on *Sitanion hystrix* appears to be very distinct, other material on *Elymus glaucus* and on *S. hystrix* is variable, some close to var. *stomaticola*, others to *S. obtusa*. Certainly our *S. obtusa* is not completely separable from the whole complex.

The host range of *Selenophoma obtusa* is as follows: *Agropyron inerme* (Wash.); *Elymus condensatus* (Wash.); *E. glaucus* (Wash., Calif.); *Poa arida* Vasey (N. Dak.); *Sitanion hanseni* (Scribn.) J. G. Sm. (Calif.); *S. hystrix* (type locality is Mt. Shasta, Calif.; Mont.); *Stipa richardsoni* (Mont., Wyo.); *Stipa* sp. (Calif.). *Selenophoma obtusa* occurs throughout the range of *S. donacis* from Mandan to Mt. Shasta but is typically a fungus of the high mountains and desert. It has been collected for instance at White Bluffs, Washington, in a region having 3 inches of average annual precipitation.

References: Sprague and A. G. Johnson (675, 676).

SEPTORIA

Most of the species included here have just been the subject of a detailed study by the writer (Sprague, 665) and therefore it does not appear necessary to discuss them in detail. It is, however, believed desirable to give the following key to the species:

A. Pycnospores 0- to 2-septate, less often 3-septate

  B. Pycnidia prominent, as much as 180-250 µ diameter

    C. Spores filiform, 36-50 x 1.4-1.6 µ .... *Septoria poliomela* Syd.

CC. Spores obclavate filiform, 33-65 x 1.2-2.5 µ ....
S. bromi Sacc.

CCC. Spores obclavate, 28-50 x 2.5-4.5 µ ....
S. infuscans (Ell. and Ev.) Sprague

BB. Pycnidia intermediate, 100-180 µ in diameter

C. Spores filiform, 2-septate, 40-56 x 1.8-2.4 µ ....
S. elymi Ell. and Ev. on *Elymus canadensis* var. *robustus* (Scribn. and Sm.) Mackenz. and Bush

CC. Spores elongate-fusiform, 26-38 x 2-2.5 µ ....
S. spartinae (Trel.) Sprague

CCC. Spores elongate-fusiform, 24-42 x 2.5-4 µ, pycnidia sometimes less than 100 µ diameter ....
S. calamovilfae Petr.

CCCC. Spores bacillar, 1-septate, 3-septate in one Mandan, N. Dak., collection .... *S. oudemansii* Sacc.

CCCCC. Spores filiform, faintly septate, 50-70 x 1-1.5 µ ....
S. cenchrina J. J. Davis

BBB. Pycnidia small, obscure, 50-120 µ diameter

C. Pycnidia typically 50-80 µ, spores 0- to 1-septate ......
S. triseti Speg. em. Sprague

CC. Pycnidia typically 80-120 µ, spores 0- to 2-septate .....
S. tenella Cke. and Ell.

AA. Spores typically more than 2-septate

B. Pycnospores usually less than 50 µ long

C. Spores averaging more than 2 µ wide

D. Spores bacillar

E. Spores seldom more than 30 µ long ....
S. nodorum Berk.

EE. Spores frequently more than 30 µ long

F. Produces a pale-colored leaf spot, spores 3-septate, 25-50 x 2.5-3.5 µ, on rye ....
S. secalis Prill. and Del.

FF. Produces dark brown leaf spots, spores 3-septate, 25-50 x 2.7-4.1 µ, on *Lolium* ....
S. loligena Sprague

FFF. Produces a pale-colored leaf spot, spores 1- to 3-septate, 37-62 x 2.6-3.4 µ, on *Stipa*, *Agrostis* ....
S. secalis var. *stipae* Sprague

FFFF. Produces a brown leaf spot, spores 3-septate, 22-38 x 2.8-3.8 µ, on *Melica* ....
S. melicae Pass.

FFFFF. Produces a pale leaf spot, brown-bordered, spores 3- to 4-septate, 25-45 x 3-4 µ, on *Avena* .... *S. avenae* Frank

DD. Spores narrowly obclavate, apex more or less pointed

E. Pycnidia 100-140 µ, on *Sporobolus* ....
S. andropogonis f. *sporobolicola* Sprague

EE. Pycnidia 75-100 µ, on *Andropogon* ....
S. andropogonis J. J. Davis

EEE. Pycnidia 130-160 µ, on *Sphenopholis* ....
S. andropogonis J. J. Davis

CC. Spores less than 2 µ wide

D. Pycnidia golden-brown, ellipsoid

E. Pycnophores 4-7 µ long, spores 35-40 x 1.3-1.6 µ
S. macropoda Pass.

EE. Pycnophores 3-4 µ long, spores 30-50 x 1.2-2.1 µ
S. elymi Ell. and Ev.

DD. Pycnidia creosote-brown, subglobose to ellipsoid, spores 14-46 x 1.3-2 µ ....
S. passerinii Sacc.

BB. Spores frequently more than 50 µ long

C. Spores narrowly filiform, about 1 µ wide ....
S. stipina Died.

CC. Spores more than 1 µ wide

D. Spores often more than 2.7 µ wide

E. Spores averaging less than or approximately 65 µ long

F. Spores strictly hyaline

G. Spores 2- to 4-septate, stiffly curved, obclavate-filiform, pycnophores 4-9 µ long .... (in part)
S. infuscans (Ell. and Ev.) Sprague

GG. Spores mostly 3-septate, somewhat whip-like, obclavate-filiform, pycnophores 5-11 µ long ....
S. bromi var. *phalaricola* Sprague

GGG. Spores 3-septate, obclavate-cylindric to narrower .... *S. agropyrina* Lob.

GGGG. Spores 3- to 5-septate, narrowly obclavate, up to 73 µ long on *Stipa comata* ....
S. andropogonis f. *sporobolicola*

FF. Spores somewhat chlorinous ....
S. mississippiensis Sprague

EE. Spores averaging more than 65 µ long

F. Pycnidia prominent, as much as 320 µ in diameter

G. Spores seldom more than 5-septate, lance-shape, obclavate ....
S. jaculella Sprague

GG. Spores 3- to 7-septate, obclavate, apex elongated ....
S. arctica Berk. and Curt.

FF. Pycnidia smaller, commonly less than 150 µ diameter

G. Pycnophores narrowly ampulliform, spores long-filiform ....
S. pacifica Sprague

GG. Pycnophores cylindrical, spores obclavate-filiform ....
S. munroae Ell. and Barth.

DD. Spores less than 2.7 µ wide but more than 1 µ wide

E. Pycnidia brown, cells compact, frequently elongated

F. Pycnophores awl-shape, 2-5 µ long

G. Spores very narrowly obclavate-filiform

H. On *Agrostis exarata* ....
S. calamagrostidis (Lib.) Sacc.

HH. On *Koeleria cristata* ....
S. calamagrostidis f. *koeleriae* (Cocc. and Mor.) Sprague

GG. Spores filiform, less often very narrowly obclavate-filiform

H. Spores typically sinuous ....
S. calamagrostidis on *Agrostis palustris*

HH. Spores usually slightly curved, but less often sinuous ....
S. calamagrostidis on *Trisetum* spp.

FF. Pycnophores short, papillate, 2-3 µ long ....
S. macropoda on *Poa howellii* Vasey and Scribn.

EE. Pycnidia golden-brown, cells moderately compact, variable in shape, not uniformly elongated

F. Spores seldom over 1.7 µ wide ....
S. macropoda var. *septulata* (Gonz. Frag.) Sprague

FF. Some spores more than 1.7 µ wide

G. Spores never 8- to 9-septate

H. Pycnophores 2- to 6 µ long ....
S. macropoda var. *grandis* Sprague

HH. Pycnophores 4 to 13 µ long

I. Spores typically sinuous ....
S. tritici f. *avenae* (Desm.) Sprague

II. Spores variously curved, less often sinuous

J. Microspores present, macrospores 25-90 x 1.4-2.6 µ, on wheat .... *S. tritici* Rob.

JJ. Microspores not known

K. Pycnospores up to 85 µ long, on *Lolium* .... *S. tritici* var. *lolicola* Sprague and A. G. Johnson

KK. Pycnospores up to 105 µ long, on *Holcus* .... *S. tritici* f. *holci* Sprague

GG. Spores 3- to 9-septate, up to 95 µ long. *S. andropogonis* var. *sorghastri* H. C. Greene and Sprague

GGG. Spores usually 5-septate, up to 60 µ long .... *S. quinqueseptata* Sprague

SEPTORIA AGROPYRINA Lob., *Leaf Spot and Blotch*.

This species is a very common but relatively unimportant component of the leaf spot complex on *Elymus* and *Agropyron* spp. in the Great Plains. Its range, however, extends west to Oregon. It apparently occurs widely in Asia and adjacent Europe. It is usually found as a saprophyte on the tips of dead or nearly dead leaves but some collections show it associated with a brown or fuscous blotch. The spores are coarse, obclavulate to sub-cylindric, and are apically pointed in most specimens. They average 40-65 x 2.5-4.0 µ and are borne in large brown pycnidia. It is difficult to distinguish this fungus from a slender phase of *Septoria infuscans* on the one hand and from *Stagonospora arenaria* Sacc. on the other. Its pointed spores more or less distinguish it from *Stagonospora arenaria*, while its development on potato dextrose agar (it forms a cottony buff colony) contrasts sharply with the scanty pellicular growth of *S. infuscans*. While typical *S. infuscans* does not appear to extend east of Yellowstone National Park, *S. agropyrina* does occur with *Stagonospora arenaria* west to Oregon.

Septoria agropyrina is readily segregated from most material of *S. elymi*, as the latter has much smaller spores and produces a yeasty colony on potato dextrose agar. There is, however, a phase of *S. elymi* that is the same as S. *elymicola* Died. which may sometimes be intermediate between typical *S. elymi* and the more slender spored collections of *S. agropyrina*. This phase usually occurs on *Elymus canadensis* or more often on *E. canadensis robustus*. This phase has been seen from Iowa and North Dakota while Hardison sent us material from Michigan.

Septoria agropyrina is further briefly discussed in connection with associated forms. It should be pointed out that critical comparison with European types is needed in this group.

References: Lobik (411); Sprague (665).

SEPTORIA ANDROPOGONIS J. J. Davis, *Leaf Spot*.

This fungus and its various forms and variety is very common in the Great Plains region. While the species proper on *Andropogon furcatus* Muhl. has not been collected closer than Kansas (Lefebvre, see Sprague, 660) and Wisconsin (Davis, 139, type area), it probably occurs on this host within the area covered by this article.

Gray elongate lesions are formed with moderately prominent pycnidia more or less seriately arranged. The spores are characteristically obclavate with tapering blunt bases and narrowly sharpened apices (Sprague, 660, fig. 1, *b*). They are usually 3-septate, 30-51 x 2-3.9 µ, and the contents are hyaline to yellowish.

One collection on *Sphenopholis obtusata* from Devil's Lake, North Dakota, appears to be *S. andropogonis* rather than *S. quinqueseptata* Sprague, which also occurs on this host.

References: Davis (139); Sprague (660).

SEPTORIA ANDROPOGONIS var. *SORGHASTRI* H. C. Greene and Sprague, *Leaf Spot*.

This differs from the species in the much longer and multiseptate spores. Except for their extreme length they are fundamentally the same type of spore on a closely related genus. The first collection of this fungus on *Sorghastrum nutans* (L.) Nash was made by Rev. J. M. Bates, many years ago, at Long Pine, Nebraska, but the specimen was undetermined until Greene and the writer compared notes with some recently collected Wisconsin material and concluded that the fungus was only an unusual phase of *S. andropogonis*.

References: Greene (290); Sprague (665).

SEPTORIA ANDROPOGONIS forma *SPOROBOLICOLA* Sprague, *Leaf Spot and Blotch*.

The type of this occurs as a non-striate circular spot on *Sporobolus* *heterolepis* A. Gray, but similar material has recently been found on *Stipa comata* at Mandan, North Dakota, which forms a blotch at first, later a light-colored spot. The spores of the type on *Sporobolus* are slightly narrower than those of *Septoria andropogonis* proper, while those on *Stipa* are somewhat longer (40-73 x 2.4-3.4 µ), but also proportionately slightly narrower. This character, plus the somewhat larger, light-colored pycnidia in f. *sporobolicola*, readily segregates the form from the species. Except for these differences they all belong in the one species. At present f. *sporobolicola* is confined to the Agrostidae; while the species proper and its var. *sorghastri* occur on the Andropogoneae except for the Devil's Lake collection on *Sphenopholis* of the Aveneae. The possibly related species *S. quinqueseptata* also occurs on *Sphenopholis*, while another related but we believe distinct species, *S. mississippiensis*, occurs on *Muhlenbergia* of the Agrostideae. It would appear that this group has adapted itself to a considerable range of tribes under the favorable conditions of association in the plains country. Since much of this information has been obtained only recently it is expected that further forms will be noted.

Forma *sporobolicola* was recently identified also on *Stipa viridula* from South Dakota. It is likely much more common than collections indicate, as much of the material on *Stipa* is not fruiting.

References: Sprague (660, 665).

SEPTORIA ARCTICA Berk. and Curt., *Leaf Spot*.

The type of this species was collected on *Dupontia fischeri* R. Br., on an island off the Siberian coast in the Bering Straits. It occurs also on *Calamagrostis nutkaensis* near Seaside, Oregon, and apparently in southern Alaska and northern Europe (Sprague, 665). The spots are ill-defined brown to dull gray lesions; pycnidia are large (140-250 µ); spores are hyaline obclavate-scolecosporous with tapering rounded bases and sharply pointed apices. The spores in the type are 2- to 3-septate or more, 60-80 x 2.8-3.6 µ, straight to stiffly curved, and somewhat resemble spores of *S. jaculella* Sprague on *Bromus* spp. On *C. nutkaensis*, the spores are 3- to 7-septate, 70-89 x 3.5-4.6 µ. It is suspected that this species is more widespread and abundant than collections indicate. It appears to be distinctly parasitic.

References: Berkeley and Curtis (42); Sprague (665).

SEPTORIA AVENAE Frank, *Speckled Blotch of Oats*.
(Ascigerous stage, *Leptosphaeria avenaria* G. F. Weber.)

A collection on some late-seeded green-manure oats on the Northern Great Plains Field Station, Mandan, North Dakota, represents the only collection of this fungus from the western area, although it is common in Wisconsin and northward and is also probably present in Minnesota.

The 3-septate bacillar spores of this fungus are close to *Stagonospora*. Since the perithecial stage is known (Weber, 752), the fungus can be referred to that stage and the questionable status of the imperfect stage is not so important as if its perithecial stage were unknown. Routine workers will recognize the pycnidial stage as a *Septoria*, although it is probably closer to the narrow-spore *Stagonospora* forms that produce cottony mycelium from germinating spores on potato dextrose agar, as contrasted with the slimy yeasty (mucose) conidial masses that most grass-inhabiting species of *Septoria* form under the same conditions.

References: Frank (237); Weber (752).

SEPTORIA BROMI Sacc., *Leaf Spot*.

Lesions on brome grasses are obscure, sometimes evident as elongate or elliptical spots, but often the infected leaves turn yellow, then dry up and become brown. The pycnidia are only moderately prominent, 60-240 µ, black-brown, and the spores are characteristically whip-like, usually 2-septate, 33-65 x 1.2-2.5 µ, or sometimes stouter in Oregon material, but not to be confused with the javelin-like spores of *S. jaculella*. The host range includes: *Bromus commutatus* Schrad. (Oreg., Idaho); *B. inermis* (Mandan, N. Dak., Oreg., Wash.); *B. japonicus* Thurb. (Wash., Wyo.); *B. mollis* (Oreg., Wash.); *B. racemosus* L. (Oreg.); and *B. secalinus* L. (Oreg., Idaho, Iowa). This fungus is seldom serious in the West.

References: Sprague (665); Weber (754).

SEPTORIA BROMI var. *PHALARICOLA* Sprague, *Buff Spot*.

This fungus occurs in buff lesions on the leaves of reed canary grass at Astoria, Oregon. The spores are obclavate-filiform, 3-septate instead of 2-septate as in *S. bromi*, 37-66 x 1.7-2.9 µ, borne in large pycnidia 150-180 x 204-276 µ. This species may be distinguished from certain other pycnidium-bearing leaf spots of reed canary grass as follows:

A. Spots pale with narrow fuscous or tinted border, spores non-septate, falcate ....
Selenophoma donacis (Pass.) Sprague and A. G. Johnson

AA. Spots buff, yellow, or obsolete

B. Spots pale or absent, spores 0- to 1-septate, falcate, from the Argentine ....
Septoria macrostoma Speg. (Sprague, 665, fig. 19, c)

BB. Spots buff

C. Spores 1-septate, hyaline, 20-25 x 1.3 µ, from Italy ..
Septoria phalaridis Cocc. and Mor. (120)

CC. Spores 3-septate, hyaline, obclavate-filiform, from Oregon and probably Italy ....
Septoria bromi var. phalaricola Sprague (665)

BBB. Spots tawny blotches, spores 38-71 x 4.5-6.0 µ (when mature), 3- to 8-septate (3-septate phase 25-40 x 2.7-4.5 µ), from Middle West and the Great Plains and in Europe ....
Stagonospora foliicola (Bres.) Bub. (See under Stagonospora below)

SEPTORIA BROMI var. PHALARIDIS Trail (Trail 709) is PHAEOSEPTORIA PHALARIDIS (Trail) Sprague (Sprague 659)

References: Cocconi and Morini (120); Saccardo (554); Sprague (659, 665); Trail (709)

SEPTORIA CALAMAGROSTIDIS (Lib.) Sacc., Leaf Spot.

The lesions are gray to straw color, usually not abundant, and occur most commonly during late winter or early spring in Oregon. The pycnidia are strongly flattened, dark brown, 50-140 x 50-180 µ in lateral diameter and 50-80 µ vertically, and are characteristically formed of compactly intertwined cells 1.7 µ in diameter. The spores are filiform, 0- to 5- septate, 25-71 x 1.0-2.0 µ, often sinuous. The host range of this species is as follows: Agrostis diegoensis Vasey (Oreg.); A. exarata (Oreg., Alaska); Trisetum canescens Buckl. (Oreg.); T. cernuum Trin. (Oreg.). The fungus on Trisetum usually has stiffer straighter spores than on Agrostis but one collection on T. canescens from Douglas County, Oregon, has spores identical with those on Agrostis. This form on Trisetum is confined to species of that genus on which it is very parasitic. It is considered to be only a race of S. calamagrostidis. Such species as S. caballeroi Gonz. Frag. (270), S. caballeroi var. panicei Gonz. Frag. (272), and S. graminum f. triseti-loeflingianii Cab. (88) are synonyms.

Our studies indicate that material on Agrostis palustris may be called race 1, on A. exarata, race 2; and on Trisetum spp., race 3.

Other fungi that may be confused are the shorter-spored *Septoria triseti* (common on *A. tenuis* but not on *A. palustris*, the reverse of the situation with *S. calamagrostidis*), and the bacillar spored *S. secalis* var. *stipae* which sometimes occurs on *Agrostis*.

References: Anderson (11); Caballero (88); Cocconi and Morini (120); Gonzalez Fragoso (270, 272); Saccardo, Peck, and Trelease (559); Sprague (642, 665)

SEPTORIA CALAMAGROSTIDIS (Lib.) Sacc. f. KOELERIAE (Cocc. and Mor.) Sprague, Leaf Spot. (S. koeleriae Cocc. and Mor.)

This fungus differs from *S. calamagrostidis* in its stiff needle-like spores, 35-60 x 1.1-2 µ, that are readily distinguishable from the species proper. It is confined to *Koeleria*.

Septoria calamagrostidis f. *koeleriae* occurs from North Dakota to Oregon and Washington. The fuscous spots are relatively abundant in spring on *Koeleria cristata* in the eastern and mountainous parts of Oregon and Washington.

References: Cocconi and Morini (119); Sprague (665).

SEPTORIA CALAMOVILFAE Petr., Leaf Spot.

The type locality of this species is Kulm, North Dakota, where it occurs on *Calamovilfa longifolia* (Hook.) Scribn. The writer has found it at Faith, South Dakota, and near Colony, Wyoming. The spores are smoky-hyaline, spindle-shape, 24-42 x 2.5-3.7 µ, 0- to 2-, sometimes 3-septate. It causes a white or pale gray spot on the leaves and sheaths.

Reference: Petrak (510, p. 86).

SEPTORIA CENCHRINA J. J. Davis, Leaf Spot.

Reported on *Cenchrus pauciflorus* Benth. from Minnesota as well as from the type area at Spring Green, Wisconsin. This species has filiform, continuous or faintly septate spores, 30-100 x 1.5-3.0 µ, borne in proportionately small pycnidia, 60-115 µ. The longer spores (Davis, 142) protrude through the wide ostiole.

References: Davis (142, p. 296).

SEPTORIA ELYMI Ell. and Ev., Speckled Leaf Blotch
(Septoria agropyri Ell. and Ev.)

This fungus causes pale gray to tan or fuscous lesions which, with the numerous pycnidia, produce the effect of speckled blotch. The spores are smaller than those of S. tritici, 25-50 x 1.2-2.1 µ, 0- to 3-septate. A form of this fungus on Elymus canadensis var. robustus in Iowa, Wisconsin, and Michigan has 2-septate larger spores, 40-56 x 1.8-2.4 µ. The form on Agropyron spp. (Ellis and Everhart, 213) has spores too nearly like those of S. elymi Ell. and Ev. (212) to be worthy of recognition as a separate species, therefore S. agropyri Ell. and Ev. (214) is considered a synonym of S. elymi. The host range also is partly interchangeable.

The host range of Septoria elymi is as follows: Agropyron inerme (Oreg.); A. repens (Oreg., Wash., Mont., N. Dak., Minn., Iowa, Nebr.); A. smithii (N. Dak., S. Dak.); A. spicatum (Wash., Wyo.); A. subsecundum (Mont., N. Dak.); A. trachycaulum (N. Dak.); Elymus canadensis (N. Dak., S. Dak., Minn.); E. canadensis var. robustus (Iowa); E. glaucus (Oreg., Wash.); E. triticoides (Calif.)

S. elymi is readily distinguished by its smaller spores from S. infuscans, S. pacifica, Stagonospora arenaria, and Septoria agropyrina, all of which occur on Elymus and Agropyron.

References: Ellis and Everhart (212-214); Sprague (665); Weber (754).

SEPTORIA INFUSCANS (Ell. and Ev.) Sprague, Brown Leaf Blotch.
(Cylindrosporium infuscans Ell. and Ev.)

Elymus condensatus and sometimes E. glaucus (Oregon and Washington), Agropyron spicatum (Oregon), and Elymus triticoides (Oregon, California) are heavily blotched by this fungus in the western States as far east as Yellowstone National Park, Wyoming. The type material and much of that from the Columbia Basin of Oregon and Washington has obclavulate, blunt-base pycnospores tapering to a stubby point at the apex, 1- to 3-septate, 28-50 x 2.5-4.5 µ (Cooke, 126, no. 113). However, some material, particularly that on E. triticoides, has obclavulate-filiform spores 1- to 4-septate, 40-75 x 1.7-2.7 µ, resembling those of S. elymi-europaei Jaap. In pure culture, both kinds produce small gray pellicular colonies with imbedded pycnidia. One isolate of a narrower form from E. condensatus, Washtucna, Washington, produced an off-white mucose growth that spread somewhat more rapidly than most of the isolates, and this may be different.

East of the range of S. infuscans, a large spored fungus in white stramineous or fuscous lesions occurs on Elymus and Agropyron. This is referable to S. agropyrina Lob. (non Unamuno, 731). It produces a buff cottony growth, similar to *Stagonospora arenaria* Sacc., in pure culture.

S. infuscans frequently has microspores, 5-7 x 1-1.5 μ, narrowly ovate, short cylindric, often curved.

References: Cooke, W. B. (126, No. 113); Ellis and Everhart (216); Jaap (357); Sprague (649, 665); Unamuno (731).

SEPTORIA JACULELLA Sprague, *Western Brome Speckle*.

This fungus has been known for only a few years, but it occurs on a leaf of *Bromus carinatus* collected by David Douglas in 1832, probably from southern Oregon. The fungus invades living tissue very slowly so that the lesions are vague, mottled or blotched, partly owing to the fact that green, brown, and yellow tissues are intermingled with mature pycnidia. Sometimes streaks of dead tissue are formed.

The pycnidia are large; the diamond blue hyaline spores are stiffly javelin or lance-shaped, 45-90 x 1.9-4.0 μ, with numerous microspores present in some collections. Efforts to obtain the fungus in pure culture have been negative; the spores will germinate on potato dextrose agar, but they soon die.

The host range is as follows: *Bromus carinatus* (Oreg., Wash; Trude, Idaho); *B. ciliatus* L. (Bradshaw Mts., Ariz.); *B. laevipes* Shear (Calif.) *B. rigidus* Roth (Oreg., Wash.), and *B. tectorum* (Wash.).

References: Cooke (127, no. 114); Sprague (650, 665).

SEPTORIA LOLIGENA Sprague, *Brown Leaf Spot*.
(*S. lolii* (Cast.) Sacc.)

Causes a deep chocolate-brown leaf spot surrounded by lighter areas. The spores are bacillar, clear hyaline, 3-septate, 28-45 x 2.7-4.2 μ, and are therefore similar to those of *S. secalis* or to *S. avenae* and not to those of *S. tritici* var. *lolicola*, which has much narrower spores.

Besides the original material from France, this fungus occurs in California on *Lolium multiflorum*. It was collected in the San Francisco area by W. B. Cooke recently (Sprague, 665).

References: Castagne (98); Sprague (665).

SEPTORIA MACROPODA Pass., *Leaf Blotch*.
(*Septoria annua* Ell. and Ev., *S. poae-annuae* Bres.)

The common leaf blotch on *Poa annua* and on *P. kelloggii* Vasey (Oregon),

P. howellii (Oregon), and P. nervosa is abundant in the northern United States wherever the hosts occur and humid conditions prevail during the growing season. It is obtainable any month of the year in coastal Oregon but is particularly prevalent in late winter. The spores are very slender, 30-40 x 1-1.5 µ.

References: Bresadola (67); Cocconi (59); Ellis and Everhart (215); Gilman and Archer (262); Sprague (665).

SEPTORIA MACROPODA var. GRANDIS Sprague, Leaf Blotch.

The spores of this variety are larger than those of S. macropoda, some of them approaching Septoria tritici, 40-70 x 1.5-2.4 µ. It occurs in the interior of the United States from the Cascade Mountains in Oregon, Washington, and California to the center of North Dakota. The host range of this variety is as follows: Poa ampla (Wash.); P. arida (Faith, S. Dak.); P. canbyi (Mont.); P. cusickii Vasey (Mont.); P. nevadensis Vasey (Oreg., Calif.); P. pratensis (Wyo.); P. scabrella (Thurb.) Benth. (Wash.); P. secunda (Oreg., Wash., S. Dak., Wyo., Mont., N. Dak.); P. vaseyochloa (Wash.). The collection on P. pratensis was more or less accidental; the common form on that host is var. septulata to be discussed later. Septoria macropoda var. grandis is very widespread in the high range country in the very early spring and has been collected as early as December in Klickitat County, Washington. As soon as the weather warms up and becomes dry in Oregon and Washington the spots lose their identity and are difficult to see. Some racial differences were noted in this variety.

References: Sprague (656, 665).

SEPTORIA MACROPODA var. SEPTULATA (Gonz. Frag.) Sprague, Leaf Blotch.
(S. poae-annuae var. septulata Gonz. Frag.)

Septoria macropoda var. septulata is cosmopolitan throughout the northern United States as the cause of a dark gray or brown spot irregular in shape on the leaves of Poa pratensis. It is readily recognizable from the species by its needle-like spores, which are 40-60 x 1.3-1.7 µ and are narrower than those of var. grandis. While these forms are similar enough to be placed in one species, they are sufficiently distinct from each other both morphologically and ecologically to be recognized as subdivisions. The var. septulata also occurs on Poa compressa and on P. nervosa.

References: Gonzalez Fragoso (273, 274); Sprague (657, 665); Weber (754).

SEPTORIA MELICAE Pass., *Leaf Blotch*.

This fungus was found in the grass nursery at the Northern Great Plains Field Station, Mandan, North Dakota, in August 1943. It caused a brown leaf spot on *Melica scabrosa* Trin. This is another of the complex of closely related species with 3-septate bacillar spores, in this case, 22-38 x 2.8-3.8 µ. It is slightly less robust appearing than *S. avenae*. There is no report on this fungus for North America except that *Schizachne purpurascens* (Torr.) Swallen is listed as a host in Seymour's list (599). The writer (666) mentions it in a recent article.

SEPTORIA MISSISSIPPIENSIS Sprague, *Leaf Spot*.

This fungus causes a buff eyespot with prominent brown borders on *Muhlenbergia mexicana* (L.) Trin. in Minnesota and on *M. asperifolia* (Nees and Mey.) Parodi in North Dakota. The spores are like those of *S. andropogonis* (see also Karsten, 378, on *S. bromi* var. *alopecuri* Karst.) except that they are chlorine yellow instead of hyaline to faintly yellow, and the contents appear much different as can be readily seen by comparing the two species (Sprague, 660, fig. 1, *a*,*b*,*c*). *S. mississippiensis* does not appear to be very abundant.

References: Karsten (378); Sprague (660, 665).

SEPTORIA MUNROAE Ell. and Barth, *Leaf Spot*.

The lesions on *Munroa squarrosa* (Nutt.) Torr. in Kansas and Colorado are straw color and obscure but the seriately arranged pycnidia are abundant. Spores are 80-110 x 2.5-3.0 µ and resemble certain species of *Cercospora*. This species has not been studied to any extent.

References: Ellis and Bartholomew (208); Sprague (665).

SEPTORIA NODORUM Berk., *Glume Blotch*.

Typical spores of the fungus causing glume blotch of wheat are short, cylindrical, 0- to 3-septate, 15-30 x 2.3 µ. This species is widely known in Europe and in the northern United States and Canada on wheat and wheat relatives as a leaf spot and later, towards harvest, as a blotch on the glumes of the maturing heads and on culm parts, particularly the nodes. In Germany, the fungus is often known as *Macrophoma hennebergii* (Kuehn) Berl. and Vogl. (43) or sometimes by the earlier name of *Phoma hennebergii* Kuehn (393). Petrak and Sydow (512) placed it in *Stagonospora hennebergii* (Kuehn) Petr. and Syd. A study of material from Germany, from North Dakota, and from adjacent regions shows that true *S. nodorum* is associated with forms that have somewhat larger spores, 25-45 x 2.5-4.3 µ. In addition material on *Elymus* and

Agropyron is confused with *Septoria agropyrina* Lob. but in the latter the apical end of the longer spores tends to be somewhat pointed and less cylindrical. Just where *Stagonospora arenaria* Sacc. ends and *S. nodorum* begins in some of the collections is also an open question. In fact there is some question as to whether *S. nodorum* is not a species of *Stagonospora*, as pointed out by Petrak and Sydow (512).

After segregating what appears to be *Septoria agropyrina* and *Stagonospora arenaria* from *Septoria nodorum*, the host range of the latter is as follows: *Agropyron repens* (N. Dak.); *A. trachycaulum* (N. Dak.); *Elymus excelsus* Turcz. (N. Dak.); *E. sibiricus* L. (N. Dak.); *Glyceria elata* (Nash) Hitchc. (Cornucopia, Oreg.); *G. pauciflora* Presl (Cascade Mts., Wash.); *G. striata* (Lam.) Hitchc. (Hoover, Oreg.); *Hystrix patula* (Minn.); *Poa palustris* (Rough Lock Falls, S. Dak.); *Poa pratensis* (Oreg.); *Triticum aestivum* L. (wheat) (Mont., N. Dak., S. Dak., Nebr., Minn., Iowa); *T. spelta* L. (Alsea Valley, Oreg.); *Stipa viridula* (Mandan, N. Dak.); *T. dicoccum* Schrank (N. Dak.).

The collections on *Glyceria* represent a fungus that may warrant separation from *Septoria nodorum*. The spots are large, buff, later paler, and the spores appear narrower than typical *S. nodorum*. The apices are somewhat pointed but the spore shape is more slender and not at all like that of *S. agropyrina*, which is a much coarser fungus. The writer (638) referred the first collection, from Hoover, Oregon, to *Stagonospora glyceriae* Roum. and Fautr., but better material has since shown that this was incorrect. Host range studies are needed with this species or form to determine its relationship to the group.

Septoria nodorum produces a buff or light-colored cottony mycelium in potato-dextrose agar and superficially resembles isolates of *Stagonospora arenaria* and of most of the other bacillar-spored forms. In producing a cottony growth, it differs fundamentally from the true *Septoria* group with filiform spores, which mainly produce masses of mucose conidia in pure culture from germinating spores.

References: Alfaro (6); Berkeley (41); Berlese and Voglino (43); Bockmann (53); Diedicke (167); Grove (295,296); Kuehn (393); Luchetti (412); Machacek (419); Passerini (503); Petrak and Sydow (512); Rosen (544); Sprague (665); Sydow (695).

SEPTORIA OUDEMANSII Sacc., *Leaf Spot*.

Light purple, finally straw color lesions occur on *Poa pratensis* and *P. compressa* during wet weather in Oregon and Washington. The lesions on these hosts and on *P. canbyi*, *P. secunda*, *P. juncifolia*, and *P. nevadensis* from the Rocky Mountains and the Northern Great Plains are obscure, sometimes vague blotches, more often faded to neutral straw color. The disease is not important, although it was severe at Mandan in August 1943. In western Oregon and Washington it occurs during the rainy period in winter and early spring. Griffith (293) indicates that the disease is important on Poa pratensis leaves in Kentucky during the cool, wet season. Seymour (599) lists S. oudemansii on Poa flexuosa var. elongata Blytt and on Hierochloë alpina (Sw.) Roem. and Schult., probably from northeast America. The first record from this country appears to be a collection made by the writer in Klickitat County, Washington, in February 1935, although he had the fungus in pure culture as early as 1932 but did not determine its identity until later. In 1935, he reported it on Poa pratensis in two places in western Oregon as Ascochyta sp. (Sprague, 629) and in 1942 corrected this to Septoria oudemansii Sacc. (Sprague, 655, 656). He also found it in material sent to him from Michigan for determination (Hardison, 310). Host range additions were noted by the writer in 1942 (Fischer, et al., 231). The fungus therefore appears to be firmly established in literature as a recognized parasite of bluegrasses in the northern United States.

In first classifying the fungus as a species of Ascochyta, the writer (629) placed the fungus where its most common spore phase should be placed. In all but one collection of several dozen seen, the spores are 12-24 x 1.7-2.8 µ, cylindrical but typically slightly thicker at the central septum. Microspores range from 4 x 2 µ up to typical Ascochyta macrospores. That this Ascochyta is potentially a species of Septoria is shown by one collection made at Mandan in rainy weather in August, 1943. The spores are 3-septate, 35-55 x 3-4 µ, mingled with spores 11-18 x 2.5 µ. In pure culture they are identical. Therefore, S. oudemansii is left in Septoria even though its common spore condition is that of a slender Ascochyta phase.

References: Allescher (7); Fischer, et al. (231); Griffith (293); Hardison (310); Seymour (599); Sprague (629, 655, 656, 665).

SEPTORIA PACIFICA Sprague, Leaf Blotch.

The spots are fuscous, soon straw color, the pycnidia prominent and seriately arranged. The spores are very slender, 1- to 8-septate, 60-110 x 1.5-3.5 µ, and therefore are too long and narrow for any phase of S. infuscans or of Stagonospora arenaria. Septoria pacifica is found on coarse beach grass, Elymus mollis Trin., along the seashore in Oregon and also on E. condensatus var. pubens Piper in central California (H. W. Johnson). A stray isolate of apparently the same species was obtained from E. glaucus in plots at Mandan, North Dakota.

The fungus produces a pale caenstone color colony, which eventually becomes covered with small-mounded, black, stromatic tissue which exudes white spore masses. The colonies, except for the color of the spore exudate, resemble the common form of S. infuscans.

Reference: Sprague (665).

SEPTORIA PASSERINII Sacc., *Leaf Blotch*.

Fuscous, somewhat indefinite lesions are formed on barley and related grasses. The leaves later turn yellow, then brown after death. The pycnidia are only moderately conspicuous against the strongly fuscous lesions. The pycnidia are creosote-brown, mostly subglobose, scarcely erumpent, 90-140 μ in diameter and up to 100 μ deep. The walls are relatively thin, 5 to 10 μ, composed of strongly pigmented cells and an inner layer of polyhedral cells. The pycnophores are somewhat filiform to subulate, 3.4-5 x 1.2-1.8 μ. The pycnospores are of two kinds: (1) Macrospores which are broadly filiform, obtusely pointed at both ends, rarely curved, 1- sometimes 3-septate, 22-44 x 1.5-2.2 μ; but saprophytic material on *Hordeum nodosum* from Sydney, Montana, had spores 45-70 x 1.8-2.4 μ, although typical material on the same host in the same general locality had spores 30-45 x 1.6-2.0 μ. Material on *Sitanion hystrix* from Mt. Hood, Oregon, had narrowly obclavate to nearly filiform spores 14-46 x 1.3-2.0 μ (mostly 40 x 1.4 μ). (2) Microspores, which are much smaller, bacteria-like, 3-6 x 0.3-0.6 μ, but occur in typical pycnidia of the species. Microspores are common on *H. nodosum* in Oregon and have been noted on *Hordeum distichon* L. from the Kiev District, Russia.

Septoria microspora Ell. on *Hystrix patula* (Indiana) has spores 9-12 x 0.7-1.2 μ (Ellis, 207) and is likely only a microspore stage of *S. passerinii*. Recently macrospores referrable to *S. passerinii* were found on *Hystrix patula* at Cotton Lake, Minnesota. (Sprague, 669).

S. passerinii is rare on cultivated barley (*Hordeum vulgare*) in the far West but is common on *Hordeum nodosum* in Oregon, Washington, Wyoming, and Montana, and is very prevalent on *Hordeum jubatum* in the Dakotas. From observations made in eastern South Dakota and from the earlier collections of A. G. Johnson (368), it is apparent that barley is commonly parasitized by this fungus in the area.

References: Ellis (207); A. G. Johnson (368); Passerinii (505); Saccardo and Trotter (560); Sprague (665); Weber (754).

SEPTORIA POLIOMELA Syd., *Leaf Spot*.

Forms gray to straw color spots on the sides and tips of the leaves of *Deschampsia caespitosa* (western Oregon) and tan to straw color lesions on the lower leaves of *D. danthonioides* in Oregon and Washington (Sprague, 655, 656). The spores are clear hyaline, strongly curved, 36-50 x 1.4-1.6 μ, 0- to 2-septate on *D. danthonioides*. On *D. caespitosa* the spores are 1- to 3-septate, needle-like, tapering towards each end or slightly blunt at one end, 33-47 x 1.5-2.0 μ, mostly about 40 x 1.8 μ. In the type collection on *Aira caryophyllea* L. from Madeira (Sydow, 694) the spores were 15-30 (50) x 1.5-2.5 μ (Sprague, 665, fig. 13,*b*), mostly 20-30 x 1.5-2.2 μ. The same fungus probably occurs in Morocco

(Maire and Werner, 429).

The fungus produced a white to pale cream color, slow growing mounded yeasty colony on potato dextrose agar which soon became covered with a short-nap, velvety, gray mycelium, similar to S. elymi (Sprague, 665).

References: Maire and Werner (429); Sprague (655, 656, 665); Sydow (694).

SEPTORIA QUINQUESEPTATA Sprague, Leaf Spot.

The type specimen from Mandan, North Dakota, occurs on Sphenopholis obtusata (665). The spores are uniformly filiform, 5-septate with obtuse bases and sub-acute apices, 48-58 x 1.9-2.4 µ, borne in pycnidia with small ostioles, 98-115 µ, on saprophytic, straw color material without any spotting.

Since the species was described, another collection on this host has been made near Devil's Lake, North Dakota, which seems to be Septoria andropogonis. The spores are 30-38 x 2.3-3.8 µ, mostly 2.8 µ wide. The pycnidia are 130-160 µ in diameter, which is atypical for most material of S. andropogonis (but see f. sporobolicola). The spots are small linear, white, finally fading to straw color. S. quinqueseptata occurs also on Koeleria cristata at Mandan, North Dakota (666). Further study may show that S. quinqueseptata is a form of S. andropogonis, which is becoming recognized as a somewhat polymorphic species on a wide range of hosts.

References: Sprague (665, 666).

SEPTORIA SECALIS Prill. and Del., Leaf Blotch.

The lesions on rye (Secale cereale L.) are yellow brown, the pycnidia are brown with walls of thick layers of light brown, rectangular cells, which give rise to creeping hyphae terminating in prominent subulate to almost fusiform pycnophores. These pycnophores are frequently bent or semi-sinuous and 5.5-8 x 1.9-2.2 µ (Sprague, 665). The spores are hyaline, 3-septate, narrowly cylindrical, 25-50 x 2.0-3.5 µ, mostly 35 x 2.7 µ and therefore slightly longer than the bare minimum of length to width ratio (10 to 1) permitted in Septoria. The microspore stage has spores about 10 x 0.5 µ and has been described as Phoma secalina Jancz. (S. secalina (Jancz.) Sacc.). S. secalis occurs in Iowa and has been collected near Washington, D. C. It was abundant in Minnesota, North Dakota, and South Dakota in 1944 as far west as Mandan. It was not serious in any fields that were examined. This species has not been found on rye in the Far West.

References: Janczewski (360); Sprague (665); Weber (754).

SEPTORIA SECALIS var. *STIPAE* Sprague, *White Leaf Spot*.

The lesions eventually become white or finally stramineous. The variety has spores 37-50 x 2.6-3.1 µ, appearing not only longer but also slimmer than the species proper on rye. The pycnidia are globose, 130-190 µ, with an erumpent ostiole which is somewhat more prominent than in the species. The variety is common on *Stipa viridula* in the Northern Great Plains and a similar fungus occurs on *Agrostis scabra* in the same region. The summer material on *Stipa* is often 1-septate and somewhat larger and proportionately more slender than *Septoria nodorum* but confusable at times. *S. nodorum* occurs on *Stipa viridula* in the region also. The same one-celled phase occurs in Oregon on *Agrostis hallii*. Also, one collection on *Stipa williamsii* Scribn. in plots at Mandan, North Dakota, had 1-septate spores only, 21-31 x 2.8-3.8 µ, and with microspores 5-10 x 0.5-0.7 µ.

Cross inoculation studies are needed to determine the host range of this variety and its relation to the species. In fact, a critical study is needed of the bacillar-spored group, including *Septoria avenae*, *S. secalis*, *S. nodorum*, *S. melicae*, *S. loligena*, and others, to determine whether some of them are not taxonomically unnecessary. In the writer's earlier investigations (665), this group was not available for adequate host range studies.

Septoria andropogonis f. *sporobolicola*, which occurred abundantly on *Stipa comata* at Mandan in 1944 has pointed, proportionately more slender spores.

References: Sprague (652, 665, 666).

SEPTORIA SPARTINAE (Trel.) Sprague, *Leaf Spot*.

Spots on the living leaves are elliptical to striate, straw to buff color, with obscure, tardily erumpent pycnidia 100 to 140 µ wide and 70 to 90 µ deep, deeply immersed, black, heavy walled, darker around the ostiole. The pycnophores are prominent, cuspidate to narrowly pyriform, arising from hyaline pycnophore initials along the floor of the pycnidium. The pycnidia are somewhat "*Rhabdospora*-like", that is, dark and heavy-walled, because they are buried in the silicified, thick leaves of the host. The hyaline, mostly 2-septate spores of material from Utah, are narrowly elongate-fusiform, tapering to a relatively sharp apex and a more gradually blunted or truncate base, 26-38 x 2.0-2.5 µ. Material from Wisconsin has spores that range up to 3.0 µ wide. *Septoria spartinae* occurs on *Spartina gracilis* Trin. (Utah) and on *S. pectinata* Lk. (S. Dak., Wis.). While it was originally described by Trelease (1885) as a species of *Ascochyta*, it is obviously closer to *Septoria*.

References: Davis (140); Sprague (665); Trelease (710, p. 121; p. 17

of reprint).

SEPTORIA STIPINA Died., *Leaf Spot*.

The lesions on the dead necrotic leaves of *Stipa columbiana* var. *nelsoni* (Scribn.) Hitchc. in eastern Oregon are vague and the material scanty. The pycnidia are prominent, dark brown, erumpent, ostiolate, finally collapsed, 100-120 x 150-200 µ, composed of compacted, creosote-brown crushed cells. The spores are straight, very narrow, 1- to 4- (mostly 3-) septate, 39-63 x 0.8-1.1 µ (average 52 x 0.95 µ)(Sprague, 665). The only specimen seen in the United States is this fragmentary one from the Blue Mountains of Oregon. It appears to be closer to *S. stipina* than any other fungus encountered. *S. stipina* was described from material gathered at Kashmir, India, on *Stipa* sp. (Sydow and Butler, 696). It has dilute brown pycnidia, 90-120 µ in diameter, with prominent ostioles and filiform, curved to flexuous, hyaline spores 25-40 x 0.5 µ. The Oregon material therefore has longer, stiffer spores borne in larger pycnidia. Other species to consider are: *S. stipae* Died. (167), which, by virtue of priority became *S. capillatae* Trott. (Sacc. 558 v. 25, p. 430.), but Grove (296) indicated that *S. stipae* Died. had irregularly bent spores allied to *S. lunata* Grove and is therefore likely a species of *Selenophoma* in the *Sel. donacis* var. *stomaticola* complex. *S. stipae* Trabut (707) has superficial pycnidia and may be a species of an aseptate-spored *Septoriopsis* Gonz. Frag. (271).

References: Diedicke (167); Gonzalez Fragoso (271); Grove (296); Sprague (665); Sydow and Butler (696).

SEPTORIA TENELLA Cke. and Ell., *Leaf Blotch*.

Small, vague, gray to greasy brown spots form on the filiform leaves of the fescues. On some hosts, the lesions are stramineous and indefinite. The pycnidia are creosote-brown, 60-120 x 95-130 µ, more or less elliptical in cross section, composed of tightly crushed, oblong to polyhedral cells averaging 0.5 to 3.0µ wide (or rarely more). The pycnophores are characteristically cylindrical, or very narrowly subulate, averaging 1 µ wide and up to 4 µ long. Sometimes the hyphae are scarcely different from the small globose to angular pycnophore initials. This species is characterized by the small size of the cells composing the pycnidial wall and by the small size of the pycnophores (Sprague, 665, fig. 12, *e*, *k*). The pycnospores of *S. tenella* are exceedingly variable, 5-70 x 0.8-2.1 µ, but most commonly they are filiform, somewhat curved, 0- to 2-septate and 25-45 x 1-1.5 µ (Sprague 665, fig. 12).

Spores on *Festuca dertonensis* from western Oregon vary from 28-41 x 0.8-1.2 µ to 7-17 x 1.0-1.5 µ and even 9-12 x 1.4-1.7 µ in adjacent pycnidia, while on F. rubra var. commutata all spore types are intermingled and found to some extent in the same pycnidium. The most common material and the most widespread occurs on F. octoflora Walt. from Idaho to Minnesota, with spores 0- to 2-septate, 44-67 x 1.6-2.1 µ. In May 1941, this fungus caused a speckled lesion on the basal leaves and culms of almost 100 percent of this grass over vast areas in the Dakotas. It was at that time the most abundant parasite on any grass in the region.

Material on F. rubra commutata from Oregon appears to be a variant similar to Septoria festucae Died. However, the material on F. dertonensis could be assigned to S. tenella, S. festucae, or Ascochyta sp., depending on the particular pycnidium examined. The material from the Great Plains is more typically and uniformly like S. tenella. It is no doubt racially distinct from the polymorphic West Coast material. S. tenella also occurs on F. ovina in the Yellowstone Park.

In pure culture, the isolates from F. rubra commutata produced a peculiar slimy cocoa brown mass of conidia, which contained many Ascochyta-like spores and also filiform spores plus many variants or freaks. Later the conidial masses, through germination of the spores, produced a somewhat carbonized surface to the colony. The isolations from near Grassy Butte, North Dakota, from F. octoflora were different in that mucose mounded, flesh pink colonies similar to Septoria tritici were formed.

A collection of a species of Phyllosticta on F. subulata had spores 4.5-11 x 1.4-2.0 µ and was assigned as being close to Septoria tenella but possibly different (Sprague, 665).

References: Cooke and Ellis (125); Diedicke (165); Sprague (665); Tehon and Daniels (701).

SEPTORIA TRISETI Speg. em. Sprague, Leaf Mottle.

This fungus that causes a spot on Agrostis tenuis is commoner than the larger spored fungus S. calamagrostidis, which does not attack A. tenuis but is common on A. palustris. S. triseti also occurs on A. alba, A. exarata, and A. castellana Boiss. and Reut. in Oregon. S. triseti causes gray, later fuscous or brown spots, and the spots are more abundant and larger than those caused by S. calamagrostidis. The spores are 18-43 x 1.1-2.0 µ, 0- to 1-septate. It is confined, as far as known, to western Oregon and Washington in the United States.

References: Spegazzini (619); Sprague (665).

SEPTORIA TRITICI Rob., *Speckled Leaf Blotch*.

Septoria tritici causes a gray speckled blotch on the leaves of wheat and other *Triticum* spp. The numerous pycnidia are golden brown, substomatal, ostiolate, usually distinctly flattened, ellipsoid, 60 to 200 µ in diameter, averaging usually 100 to 150 µ. The thin walls are composed of 2 to 5 outer layers of golden brown, oblong, box-shape, thin-walled cells; then inside that, 1 to 4 intermediate layers of polyhedral compacted cells; and inside this a thinner area of hyaline tissue that gives rise to narrowly ampulliform pycnophores. Grove (295, 296) lists *Septoria graminum* Desm. var. *crassipes* Grove on leaves of wheat and states that this variety has short ampulliform cuspidate sporophores measuring 10-13 x 2.5-3 µ. Grove's illustrations (295) indicate that he had the same fungus as the one on wheat in the western United States. The western material has flask-shape to almost cylindrical pycnophores measuring 5-13 x 1.3-3 µ (Sprague, (665, fig. 1).

Septoria tritici produces both microspores and macrospores. The macrospores are the more prevalent; they are 1- to 5-septate, narrowly obclavate-filiform, hyaline, 22-98 x 1.4-2.1 µ, mostly 45-80 x 1.6-2.0 µ. Summer material, often erroneously called *S. graminum* Desm., tends to more nearly filiform spores, shorter and with fewer septa.

Microspores are curved or hooked, aseptate, 5-9 x 0.3-1 µ, and are borne in small pycnidia 45-50 µ. The spores are so minute that they have no doubt been mistaken for bacteria. In pycnidia, 55-70 x 60-80 µ, sometimes both microspores and macrospores occur. Microspores may be produced on the tips of ampulliform pycnophores or on the tips of aborted macrospores (Sprague, 665, fig. 1). The microspore stage has been reported only from Oregon but has likely been overlooked elsewhere.

Septoria tritici occurs on *Triticum aestivum*, *T. spelta*, *T. dicoccum* var. *farrum* Bayle, and *T. turgidum* L. It is an important parasite on winter wheat in the moister parts of Oregon, Washington, and California and sometimes is serious in Nebraska and Kansas. It is less common east of the Cascade Mountains in Oregon and Washington and becomes decreasingly important eastward until it is virtually nonexistent in the Spring Wheat Belt of the Northern Great Plains. In parts of Oregon and Washington winter rosettes of wheat are 100 percent covered with the salt and pepper lesions of *S. tritici* and this injury cannot but have a depressing effect on the host, even though the fungus often disappears entirely when warm, drier weather comes in spring and summer.

It has been shown by Weber (753) that *S. graminum* does not occur on wheat in Wisconsin, while the writer reported that *S. tritici* was the only filiform-spored species present on wheat in the United States (665) and that *S. graminum* (642) was apparently limited to *Brachypodium* spp. and does not, as far as known, occur in this country. Most of the species that the writer assigned to synonomy are obvious synonyms, but one, S. briosiana Mor. (473), is less obvious. In this form microspores (9-11 x 0.5-0.75 µ) are borne on more or less abortive macrospores (32-40 x 1.5-2.0 µ). Similar conditions have been noted in this country.

Septoria tritici produces mucose, flesh color colonies, on potato-dextrose agar, which later become carbonaceous, finally subcottony.

Roberge, not Desmazières (153), should be credited with the naming of this species.

References: Baudyš and Picbauer (25); Beach (28); Cormier (130); Desmazières (153-155); Grove (295, 296); Luthra et al. (416, 417); Morini (473); Rivera (536); Rosella (542); Saccardo (555,556); Sprague (642, 665); Unamuno (731); Weber (753).

SEPTORIA TRITICI f. AVENAE (Desm.) Sprague, Speckled Leaf Blotch.

At one time the writer (626) concluded that S. tritici on oats was nothing more than a physiologic race of the species, but further study disclosed that the form on oats is distinguishable by its more sinuous spores averaging slightly narrower than those on wheat. Forma avenae is limited to oats and does not attack wheat or any known grass. The form occurs on Avena sativa, A. byzantina (red oats), and A. fatua (wild oats) in Oregon and Washington, and in Europe, New Zealand, and Argentina. It is seldom abundant except during moist open weather in winter in the Willamette Valley and adjacent areas. Red oats and wild oats are particularly susceptible.

References: Desmazières (155); Sprague (626, 665).

SEPTORIA TRITICI f. HOLCI Sprague, Speckled Leaf Blotch.

Cross inoculation trials show that this fungus is confined to Holcus lanatus. It is common in wet weather in the winter and early spring in western Oregon and Washington. The spots are irregular, eventually umber color, with numerous pycnidia. The spores are long, filiform, 1- to 4-septate, 35-105 x 1.3-2.0 µ, and are narrower and longer than typical S. tritici on wheat.

Reference: Sprague (665).

SEPTORIA TRITICI var. LOLICOLA Sprague and A. G. Johnson, Speckled Leaf Blotch.

The lesions are at first green or yellowish but later turn fuscous to deep brown. The pycnidia are obscure because of the dark color of the older lesions. They are subglobose to globose, sometimes ellipsoid, 80-150 x 90-180 µ, mostly 120-150 x 120-150 µ in diameter. The spores are hyaline, sometimes with coarse protoplasm, sometimes containing small oil drops, which in slightly immature specimens are as large as 1 u in diameter. The spores usually are slightly enlarged at the base, curved or sinuous, sometimes whip-like, 0- to 5-septate, commonly 1- to 3-septate, 21-85 x 1.3-2.8 µ (Sprague, 665, fig. 2). On *Lolium perenne* and less often on *L. multiflorum*, the spores are often more variable, with short, 1-septate spores occurring with the larger ones. They differ from those of *S. tritici* on wheat in the slightly more whip-like appearance due to the slightly enlarged bases and somewhat more tapering distal portions.

Septoria tritici var. *lolicola* occurs on *L. perenne* and *L. multiflorum* in western Oregon and in France. The early taxonomy of this fungus is greatly confused. Desmazières, no. 2169 in his Fungi Cryptogames de France (1851), described *S. graminum* var. *lolii* Mont., which now appears to be a smaller spored fungus, *Ascochyta desmazieri* Cav. (99). But var. *lolicola* was also present in this material, as well as *Rhabdospora lolii* Cast. (98). The latter fungus was transferred to *Septoria* under the name *S. lolii* by Saccardo (in Sylloge Fungorum v. 10), who failed to note *S. lolii* West. (763) which latter is the same as *A. desmazieri*. The fungus called *R. lolii* Castagne, according to rules of nomenclature, was nameless and hence was transferred to *S. loligena* by the writer. In all this welter of names, the filiform spored *Septoria* also escaped without a name and was therefore called *S. tritici* var. *lolicola*.

References: Castagne (98); Cavara (99); Desmazières (156); Sprague (665); Westendorp (763).

STAGONOSPORA SPP.

Key to species:

A. Spores over 8 µ wide (30-45 x 8-11 µ) ....
Stagonospora simplicior Sacc. and Berl.

AA. Spores narrower

- B. Spores somewhat boat-shape, 20-35 x 6-8 µ ....
  St. subseriata Desm.

- BB. Spores more or less cylindrical
  - C. Spores somewhat fusiform, 15-30 x 2-3.2 µ
    - D. Spores somewhat truncated at base ....
      St. agrostidis f. *angusta* Sprague

DD. Spores more fusiform than truncated .... St. bromi A. L. Sm. and Ramsb.

CC. Spores definitely cylindrical

D. Spores 25-70 x 2.5-5 µ .... St. arenaria Sacc.

DD. Spores 30-80 x 4-9 µ .... St. foliicola (Bres.) Bub.

This genus Stagonospora is separable from Septoria with difficulty, because on grasses there is a group of fungi, some placed in Septoria, some in Stagonospora, that have spores about 30-40-60 µ long x 3-4-6 µ wide and therefore lie on the border between filiform and cylindrical. Some workers consider Stagonospora as having coarse spores similar in all respects to Hendersonia, except for color, and similar also to Hendersonia in being mainly weak parasites or saprophytes (Kirschstein, 384). There are exceptions to this classification that make its value questionable. In general, the writer uses the length-width ratio of 10 to 1 as the division point between cylindrical and filiform. Since the length of the spores of many of these species range from about 9 to 1 to 13 to 1, they become difficult to classify. In such cases they are left in the genus to which they are customarily referred; e.g. Septoria nodorum, Stagonospora arenaria, Septoria avenae, and Stagonospora arrhenatheri A. L. Sm. and Ramsb. The forms with filiform spores produce yeasty masses of conidia on germinating on potato-dextrose agar while those with cylindrical spores are more likely to produce cottony mycelium and produce spores in true pycnidia. However, some produce small crustose colonies in which pycnidia are embedded in a matrix (Septoria infuscans), so that at least three groups are recognizable. If we place these intermediate forms in Septoria, the genus should be segregated into three sections as follows:

A. Spores filiform or narrowly obclavate, producing conidia from germinating spores on potato-dextrose agar......Section Filisporae (Various typical species of Septoria)

AA. Spores clavulate or coarser, producing pycnidia in crustose colonies on potato-dextrose agar........ Section Clavulosporae (Species such as Septoria infuscans)

AAA. Spores narrowly cylindrical, producing spores in true pycnidia in pure culture on potato-dextrose agar.... Section Cylindrosporae (Species such as Septoria nodorum, S. avenae, S. loligena, S. secalis, S. melicae, S. oudemansii and S. agropyrina)

STAGONOSPORA AGROSTIDIS f. ANGUSTA Sprague, Leaf Blotch.

This is an obscure fungus associated with other fungi on leaves of

Stipa viridula in western North Dakota (Sprague, 666). It has fusiform spores but the bases are characteristically sub-obtuse or truncated. The spores are small, 15-27 x 2.2-3.2 µ, borne in globose, golden-brown pycnidia, 120-280 µ in diameter. It is probably of slight importance economically. Morphologically it is closest to St. agrostidis Syd. (697, p. 4). The spores differ in shape from those of Septoria nodorum.

STAGONOSPORA ARENARIA Sacc., Purple-brown Blotch.

In well-developed but not old-weathered material, the spots or blotches are purple-brown, purple or nearly sepia or deep brown. Older material may be light straw color with tawny borders or old material may be completely faded to neutral straw color. The lesions are sometimes numerous, as on Fluminea festucacea (Willd) Hitchc., or sometimes scattered and obscure, as on Elymus. The lesions do not retain their dark color very long but fade in the center, paling to the neutral straw color mentioned above. St. arenaria occurs on several species of Elymus and Agropyron and morphologically similar material occurs on Cinna latifolia (Trevir.) Griseb., Oryzopsis hymenoides, and Fluminea festucacea in the western area. On Elymus and Agropyron, this fungus merges with Septoria nodorum, S. avenae, and S. agropyrina, as mentioned previously, and there exists some uncertainty as to where to draw species lines in this polymorphic group. Since the publication of an earlier article (Sprague, 653), it has been determined that the fungus on Phalaris is an immature or small-spored phase of St. foliicola (Sprague, 666; and below under St. foliicola). It is now apparent, also, that St. arrhenatheri should not be classed with St. arenaria but with Septoria avenae, from which even St. arenaria is doubtfully distinct on some hosts.

Host range studies are needed with this group in order to determine racial affinities of St. arenaria. It is no doubt a complex of races.

References: Sprague (653, 665, 666).

STAGONOSPORA BROMI A. L. Sm. and Ramsb., Purple-Brown Blotch.

This fungus causes a purple-brown blotch on the leaves of brome grasses. The disease is very destructive in Michigan (Hardison, 310) and the writer has collected it on Bromus carinatus in grass plots at Park River, North Dakota. He also recently found it on B. vulgaris (Hook.) Shear near Lake Itasca, Minnesota.

The fungus has 3-septate fusiform spores, mostly 17-24 x 3 µ. Its life history should be studied in comparison with Septoria nodorum, but it appears to be different. St. bromi is much more parasitic than St. agrostidis f. angusta and the spores are clearly hyaline and with less truncate bases.

References: Grove (296); Hardison (310).

STAGONOSPORA FOLIICOLA (Bres.) Bub., *Tawny Blotch*.
(*St. vexata* var. *foliicola* Bres., *St. vexata* var. *baldingerae* Sacc.)

This is an active parasite on the leaves of *Phalaris arundinacea* in North Dakota, South Dakota, Iowa, Minnesota, and Wisconsin. It also occurs on *P. californica* Hook. and Arn. in Marin County, California. In field plots at Mandan, almost all of the leaves are covered with the tawny blotch in late season. Some difference in susceptibility was noted among plants in this nursery.

In the Mandan material, the spores are hyaline, multiseptate, and very large, 30-80 x 5-9 μ, obclavate-filiform to obclavate-cylindrical. (Sprague, 666). All of the material that has been seen previously was immature and resembled somewhat fusiform material of *St. arenaria* (Sprague, 653). From a study of developing material at Mandan during the summer months, it is now evident that these collections are clearly part of the life cycle of the coarse-spored *St. foliicola*. The inclusion of this material in *St. intermixta* (Cke.) Sacc. by J. J. Davis (144, p. 73), who had only the developing phase, had confused the writer in earlier studies. The fungus produces a white to pale pink, somewhat weak cottony growth on potato-dextrose agar.

STAGONOSPORA SIMPLICIOR Sacc. and Berl., *Leaf Mold*.

This species is, for the most part, a saprophytic leaf mold. The symptoms consist of vague stramineous or gray areas on dead leaves. Pycnidia are more or less gregarious, 100-140 μ in diameter in our material, black, globose, ostiolate; and the pycnospores are cylindrical or slightly bent, obtuse, slightly or scarcely constricted at the septa, 3-septate, with coarse contents, often one huge hyaline inclusion in each cell; spores are hyaline or faintly yellow, borne on blunt pycnophores, 28-35 x 8-9 μ on *Calamovilfa longifolia* in North Dakota as compared with 32-38 x 8-9 μ on *Phragmites communis* in the type from France. Our local material, collected in September on dead leaves, appears to be saprophytic. However, *St. simplicior* var. *andropogonis* Sacc. was described from North Dakota (Dr. J. F. Brenckle). Greene sent material of a fungus on *Sorghastrum nutans* from Madison, Wisconsin, that he determined as this variety, and it appears to be parasitic, causing elliptical spots on living leaves. *St. simplicior* is likely to prove rather widespread on coarse grasses in our region but, except for the Wisconsin material, it has not, as mentioned, been shown to be associated with living host parts.

STAGONOSPORA SUBSERIATA (Desm.) Sacc., *Leaf Mold*.

This species has boat-shaped spores 20-40 x 4-7 µ borne in pycnidia on various hosts in the western United States (Sprague, 652). It occurs on *Poa pratensis* and *Phleum pratense* in northern Minnesota. The species appears to be saprophytic on most of the hosts seen. *St. subseriata* var. *maculata* Grove (296) is an active parasite, however, on orchard grass in England (Grove, 296), Pennsylvania (Sprague, 652), and Maryland.

References: Grove (296); Sprague (652).

STAGONOSPORA SPP., *Molds*.

A considerable number of species of *Stagonospora* occur on dead culms, leaves, and sheaths of grasses. These are particularly common on coarse marsh grasses such as *Phragmites communis*. So many species have been described on this grass, for instance, that it is practically impossible for most workers, and that includes the writer, to determine these with available facilities. Since most or all of these fungi are saprophytes their interest is purely mycological and of no importance to the pathologist.

WOJNOWICIA GRAMINIS (McAlp.) Sacc. and D. Sacc., *Secondary Rootrot*.

This fungus was removed from *Hendersonia* because of short hairs on the neck of the pycnidium. As a diagnostic character this has doubtful merit.

W. graminis is an associate of *Cercosporella herpotrichoides* in the prairies of the Columbia Basin but also occurs beyond this region into the dry land wheat regions of the West. It occurs commonly in Kansas, Colorado, and westward. It is not abundant in North Dakota in the spring wheat region, but is sometimes isolated from the roots or occurs on necrotic leaves of quack grass, orchard grass, and certain other species. It has been noted on about 29 species of Gramineae in the West.

Wojnowicia graminis, while scarcely parasitic, is of some economic importance because it weakens the culms of ripening grain, causing them to lodge prematurely. This condition is common in the Palouse in areas not affected by *Cercosporella herpotrichoides*. The effect of weak parasites and saprophytes on lodging of ripened grain has not been given sufficient attention. Carroll (95), in Eire, discusses this problem to some extent.

The spores of *W. graminis* are yellow brown, slightly flattened on one side, curved spindleform, 24-38 x 3-5 µ, usually 7-septate. An isolate from the roots of *Agropyron repens* in North Dakota had spores measuring

43-51 x 4.5-6 u but otherwise typical.

References: Broadfoot (68); Carroll (95); Ludbrook (413); McKinney and Johnson (448); Sprague (630, 667).

2. MELANCONIALES

COLLETOTRICHUM GRAMINICOLUM (Ces.) G. W. Wils., *Anthracnose*.
(*C. cereale* Manns)

Colletotrichum graminicolum is said to attack the roots, stems, leaves, and spikes of cereals and grasses, causing spots and injury generally known as anthracnose in which the black spots due to pustules (acervuli) produce a somewhat scab-like effect on the diseased surface. The fungus may develop saprophytically in late season with little evidence of its presence except for setae which give the diseased part a slightly moldy appearance.

In our area it occurs on *Agropyron desertorum* (Fisch.) Schult. *A. repens*, *A. trachycaulum*, *Agrostis alba*, *Alopecurus aequalis* Sobol, *A. pratensis* L., *Andropogon furcatus*, *Anthoxanthum odoratum*, *Arrhenatherum elatius*, *Avena fatua*, *A. hookeri* Scribn., *A. sativa*, *Bromus purgans* L., *Calamagrostis inexpansa*, *C. rubescens* Buckl., *Dactylis glomerata*, *Digitaria sanguinalis*, *Festuca octoflora* Walt., *Hordeum vulgare*, *Lolium multiflorum*, *L. perenne*, *Oryzopsis micrantha* (Trin. and Rupr.) Thurb., *Phleum pratense*, *Poa pratensis*, *Schizachne purpurascens* (Torr.) Swallen, *Secale cereale*, *Sorghum vulgare* var. *sudanense* (Piper) Hitchc., *Sphenopholis obtusata*, *Sporobolus heterolepis*, *Trisetum cernuum*, and *Triticum aestivum*. The fungus is particularly common on *Anthoxanthum* and *Arrhenatherum* in the coast region of Oregon. While common in Minnesota, it is less prevalent in the drier regions to the west.

The acervuli have prominent black setae 60-120 x 6-8 μ. The conidia are spindle-form to falcate, 18-26 x 3-4 μ, borne on short conidiophores, 12-6 x 1-2 μ.

Bolley (1913) reported *Colletotrichum* on the roots of wheat in North Dakota. The illustration indicates that he was dealing with a fungus that the writer has isolated in large numbers from diseased roots of many cereals and grasses. The cultures produce pink or orange slimy yeasty (mucose) masses of kidney-shape or falcate spores 4-8 x 1.4-2.5 μ. The colonies later develop black leathery wrinkled mycelium in which *Phoma*-like bodies sometimes occur, or less often there may be strands of pseudo-setae which never develop into true horny setae. Inoculations with a number of these isolates have been negative, although in one case an isolate obtained in August was parasitic on several hosts. Subsequent trials with this were negative and the end result in doubt. The writer has called these cultures *Gloeosporium* spp. Whether they are a phase of C. graminicolum is doubtful. Certainly they are different in culture from "C. cereale" of Selby and Manns (589). Selby and Manns obtained true mycelium development on glucose agar without mucose development of spore masses. Setae were sparingly produced and the spores were falcate, not dissimilar to those on the host. The North Dakota Gloeosporium resembles in its development some strains of Colletotrichum gloeosporioides Penz. in pure culture (Burger, 83) although the spores of the latter are larger.

References: Böning (60); Bolley (56); Burger (83); Chowdhury (105); Fischer, et al. (231); Koehler (386); Sanford (576); Selby and Manns (589); Wilson (766); Winter (773).

GLOEOSPORIUM GRAMINUM Rostr., Anthracnose.

What answers to the description of this fungus was found on leaves of Poa pratensis in two localities in Benton County, Oregon, (Sprague, 637). It may be related to the Gloeosporium-like fungus reported under Colletotrichum graminicolum above.

PSEUDODISCOSIA AVENAE Sprague and A. G. Johnson, Red Leather Leaf

In western Oregon and Washington, entire fields of winter oats sometimes show a brilliant red color in February and March. In other cases, the disease is confined to small scattered patches in which the leaves nearly all show a general reddish or reddish-brown color. All but the innermost leaves of a plant may be affected. These lesions cause a leathery, fawn to red or brown appearance. An excess of red anthocyanin pigmentation in the uninjured portions of diseased leaves gives the reddish-brown color of affected plants. The diseased plants are stunted, compact, and rigid; and the leaves are slightly rolled.

This fungus is widespread on common and red oats in the vicinity of Corvallis, Oregon, in the winter and early spring and may also be found as far east as southwestern Klickitat County, Washington. The type locality is an isolated high prairie in the latter region near the Columbia River gorge. In this area the diseased plants of Winter Turf (Gray Winter) oats showed 40 percent reduction in yield over the healthy ones. The disease is of some importance, although the oats recover to a considerable extent as soon as warm weather arrives in the spring. "Red leather leaf" is almost unrecognized as a definite disease, even at Corvallis, the symptoms being confused with red leaf symptoms in general (Sprague, 644). Many specimens of this disease are mailed to the Oregon Agricultural Experiment Station. It occurs only on fall-seeded oats.

Recently Bremer (64) reported this fungus from Turkey where it appears to be indigenous.

Pseudodiscosia avenae produces the fusiform, basally ciliated spores on very short conidiophores compacted together on a poorly developed stroma in the epidermis. There is no apparent rupture of the leaf epidermis as in typical acervuli, and in assigning this originally to the Melanconiales, the describers considered the stroma as closer to the Melanconiales than to the Moniliales (Sprague and A. G. Johnson, 672). There still appears to be no better place to assign this species.

References: Bremer (64); Sprague (625, 628, 632, 641, 644); Sprague and A. G. Johnson (672).

SEPTOGLOEUM SP.

This fungus causes dark brown to black lesions on the pedicels and foliage of Festuca idahoensis Elmer near Trude, Idaho. The spores are large, stoutly club-shape to cylindrical with blunt bases and tapering apices, which are sometimes pointed. They are usually aseptate, hyaline, 44-53 x 4.6-5.6 µ. This fungus is distinct from any species known to the writer. Until final study can be made with prepared material the fungus is assigned to Septogloeum rather than Septoria.

Reference: Sprague (669).

SEPTOGLOEUM OXYSPORUM Sacc., Bomm., and Rouss., Blotch and Char Spot.

The young lesions on the leaves are tawny with yellow margins, circular at first but soon elliptical to elongate. On Arrhenatherum elatius the fungus rarely forms black stromata, but on other hosts the lesions caused by a similar if not identical fungus become covered with dull-black, charcoal-like streaks, 2-5 mm wide and often several times as long. While the charcoal spots range from nearly circular to elongate, they are typically elongate, tapering to a point at each end. The center of the lesion is often paler than the periphery, being pale gray or isabelline from accumulation of conidia in some instances. Sometimes pycnidia occur as small black dots at the margin of the lesion, but more often, if they are present, they are obscured by the charcoal-like stroma and are not visible to the naked eye.

Spores are borne in stromatic tissue in obscure acervuli or in pycnidia in the center of the lesions, conidia arising from hyaline, globular or cuspidate conidiophores in great, grayish masses; conidia yellow to subhyaline, fusoid, often flattened slightly on one side, subtruncate at the base, tapering to an obtusely pointed apex. The conidia are 0- to 3-septate, mostly 2-septate, 17-38 x 2.5-5.9 µ; on Agrostis, they are 21-31 x 3.2-4.4 µ; on Arrhenatherum, 24-33 x 3.5-4.7 µ; on Calamagrostis, 22-27 x 3.5-4 µ; on Distichlis, 20-25 x 4.3-5 µ with relatively short, thick spores ranging from fusoid to nearly cylindrical; and on Elymus and Agropyron, they are variable, 17-38 x 2.5-5.0 µ.

Pycnidia in the char spots are subglobose, brown, more or less imbedded in the creosote brown stromatic tissue, or separate at the margin of the lesions, 80-160 µ in diameter, with variable ostioles sometimes 60 µ in diameter. The pycnospores aré similar to the conidia but are hyaline. Associated perithecia in the stroma are globose and up to 250 µ in diameter and are sometimes filled with hyaline prosenchyma. The perithecial walls are composed of creosote-brown compacted polygonal cells. The asci consist of short fascicles without paraphyses but in material seen to date on *Elymus condensatus* none of it is mature enough to determine.

Synonyms:

Mastigosporium album var. *athrix* Eriks. Fungi par. scan. exsicc. Fasc. VIII, 351-400. 1891. (Bot. Centralbl. *47*: 296-298. 1891).
Fusoma biseptatum Sacc. Krieger, W. Fungi sax. exsicc. Fasc. XIV, no. 683. 1891
F. triseptatum Sacc. Sylloge Fungorum v. *10*. 1892
Fusarium osiliense Bres. and Vest. Vestergren, Verzeichniss nebst Diagnosen und kritische Bemerkungen zu meinem Exsiccatenwerke "Micromycetes rariores selecti." Fasc. VII-X. Botan. Notis. 1900: 27-44. 1900
Septogloeum athrix (Eriks.) Sprague (640)

The host range of *Septogloeum oxysporum* includes the following hosts listed by States: *Agropyron spicatum* (Wyo.); *A. trachycaulum* (N. Dak., S. Dak.); *Agrostis hallii* (Oreg.), *A. alba* (Wyo.); *A. scabra* (N. Dak.); *Arrhenatherum elatius* (Oreg.); *Bromus ciliatus* (Colo.); *Calamagrostis inexpansa* (N. Dak.); *Distichlis stricta* (Torr.) Rydb. (N. Dak.); *Elymus condensatus* (Calif., Wyo., Mont., Wash.); *E. glaucus* (Utah); *E. triticoides* (Calif.); *Muhlenbergia asperifolia* (N. Dak.).

This fungus is not of great importance but at times is epiphytotic on grasses in humid areas.

There is still reason to question whether true *S. oxysporum* that occurs on *Arrhenatherum* is the same species as the char spot fungus found on other hosts. Life history studies are certainly needed. The char spot fungus with its *Septogloeum*-like stage is associated with an ascomycete which is close, taxonomically, to *Dothidella aristidae*. The entire charspot-tarspot situation is still further confused when the discussion by Greene (289, pp. 86-87) is noted, regarding *Davisiella elymina* (J. J. Davis) Petr. and other fungi. Members of the group *Davisiella* are either conidial phases of *Phyllachora* spp., or are associated saprophytes or even parasites. They appear to form part of the same over all problems as does the char spot and *Septogloeum* complex. The writer agrees with Greene that likely more than one fungus is involved in the whole Middle Western and Far Western situation.

References: Bommer and Rousseau (57); Greene (289); Sprague (651).

SEPTOGLOEUM SPARTINAE (Ell. and Ev.) Wr.
(Fusarium spartinae Ell. and Ev.)

This fungus has not been seen by the writer. The sporodochia are pale-yellow, floccose; conidia oblong elliptical to oblong fusoid, 1-3 septate, 12-15 x 3-4 µ. Saccardo (558, v. 18, p. 675) lists it on Spartina stricta (= S. leiantha Benth.) from Pacific Grove, California. It is listed by Seymour (599) on S. alternifolia Loisel. var. glabra (Muhl.) Fern. (= S. alternifolia Loisel).

References: Ellis and Everhart (216, p. 14); Saccardo (558, v. 18, p. 674-675); Seymour (599); Weiss (757, p. 547); Wollenweber and Reinking (776, p. 336).

3. MONILIALES

ALTERNARIA SPP. (and STEMPHYLIUM SPP.), Black Molds.

Species of Alternaria occur as saprophytes on aerial parts of many plants. They are one of the components of seed mold of wheat, called "black germ" in Siberia, "puntatura" in Italy, "moucheture" in Morocco, and such names as "kernel smudge", "black point" (in part), seed blight or "durum blight" in the United States and Canada. A melanistic (black skin pigment) browning of wheat lemmas is termed "Alternaria blotch" by Johnson and Hagborg (374).

Almost all careful research on Alternaria molds on wheat shows that they are saprophytic or at most, scarcely parasitic. They are economically important in that their presence may cause dockage losses to the grower, particularly in North Dakota durum wheat used for macaroni (Brentzel, 65).

The taxonomy of this group is in some confusion. Generally A. tenuis Nees is recognized as the common mold on Gramineae while Bockmann (54), among others, includes A. peglionii Curzi and A. circinans (Berk. and Curt.) Bolle.[4]

A. tenuis is isolated frequently from dead roots of old grass and cereal plants and less often from roots of seedlings. Our trials do not show any reason to believe that the fungus is parasitic to any extent on germinating seeds (Sprague, 663). This was shown by E. C. Johnson (372) 32 years ago.

Because A. tenuis is often associated with more parasitic species, such as Helminthosporium sativum Pam., King, and Bakke, moldy wheat seed should be treated with New Improved Ceresan at 1/2 oz. per bushel, and grass seed with New Improved Ceresan at 1 oz. or Semesan at 4 oz. per bushel.

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[4] The writer is indebted to David R. Sumstine, Carnegie Museum, Pittsburgh,13, Pa., for determination of the cultures of Alternaria isolated from Gramineae.

References: Bockmann (54); Bolley (56); Brentzel (65); Christensen and Stakman (113); Curzi (134); Elliott (206); Groves and Skolko (298, 299); Hagborg (303); Hanson and Christensen (309); Henry (321); Johnson, E. C. (372); Johnson, T. and Hagborg (374); Machacek and Greaney (420); Peyronel (514); Rosella (543); Sallans (562, 563); Wiltshire (768); Ziling (780).

ANSATOSPORA BROMI (Sprague) Sprague, Blotch
(Cercospora bromi Sprague)

Gray to sordid, elliptical or striate spots with broader dark brown or umber margins occur on Bromus rigidus Roth in two widely separated areas in Oregon and in southwestern Washington, and also on B. vulgaris in coastal Oregon.

This fungus is notable for the peculiar secondary conidia, which are attached and down-deflected from the first or second basal cell of the conidia. Evidence from study of material on B. vulgaris indicates that this species (A. bromi) may not be the cause of the spot on that host. On the basis of Newhall's study (481) of a disease of celery our fungus was placed in Newhall's newly created genus Ansatospora (Sprague, 666).

References: Newhall (481); Sprague (634, 655, 666).

CEPHALOSPORIUM ACREMONIUM Cda., Black-Bundle Disease.

This fungus occurs in the eastern part of the Great Plains and in California. It is thought to be the cause of a black fibrovascular bundle condition, which is accompanied by development of nubbins in corn, multiple ears at one node, barrenness and purple discoloration of the plant. The fungus is seed and seedling-borne. It was well described by Reddy and Holbert (530).

References: Corda (128); Harris (311); Koehler (385); Koehler and Holbert (388); Reddy and Holbert (530).

CERCOSPORA SPP.

This genus has been the subject of part-time investigations by Dr. Charles Chupp for many years. The reader is referred to his mimeographed article (114). One of our species, C. bromi, would on the basis of Chupp's suggestions to Newhall (481) belong in the genus Ansatospora Newhall to which we have referred it (Sprague, 666) (see above). The few species of Cercospora that occur on western grasses are briefly mentioned.

References: Chupp (114); Newhall (481); Sprague (666).

CERCOSPORA AGROSTIDIS Atk., Leaf Spot.

This fungus forms broadly elliptical, very light brown lesions 3-5 mm long with broad dull red borders on leaves of *Agrostis* in Alabama. Some fragmentary material on *Sphenopholis obtusata* from North Dakota, sent by the writer to Dr. Chupp, was assigned to *C. agrostidis*. The conidia are hyaline to tinted, 1- to 7-septate, terete, straight or slightly curved, 10-60 x 2.5 µ.

References: Atkinson (20); Underwood and Earle (732, p. 141).

CERCOSPORA FUSIMACULANS Atk., Brown Blotch.

The lesions are amphigenous, light brown, bordered by dark brown, broadly fusoid or elliptical, frequently confluent, 3-4 mm long.

The conidiophores are epiphyllous, fasciculate, olive-reddish-brown, straight, sub-geniculate or nodulose, sparingly denticulate towards the apex, septate, 50-100 x 4-4.5 µ, bearing small, hyaline, 3- to 4-septate conidia that taper a little toward each end, 25-40 x 2 µ.

The rather obscure blotch symptoms have prevented this fungus from being recognized widely. It occurs on *Panicum pacificum* Hitchc. and Chase on the exposed slope of Mary's Peak, Oregon, (O.S.C. 9898), and occurs in the Great Plains on *P. virgatum* (N. Dak.), in Iowa on *P. dichotomiflorum*, and in Alabama on *P. dichotomum* L.

It is reported also on barnyard grass (*Echinochloa crus-galli*) from Iowa (Gilman and Archer, 262). In this connection, the writer recently sent to Dr. Chupp material of a spot on barnyard grass found along the Missouri River bottoms, near Mandan, North Dakota, (September, 1944). Dr. Chupp replied as follows: "I examined the *Cercospora* on *Echinochloa crusgalli* (L.) Beauv. which did not resemble the Davis type (of *C. echinochloae*) at all. For instance, *C. echinochloae* has more or less cylindric conidia, straight to strongly curved, 1-7 but mostly 2-3 septate, 3-5 x 20-55 µ. The conidiophores are hypophyllous, short, 4-5.5 x 10-25 µ. Your specimen has acicular to obclavate conidia, almost straight, multiseptate, 2-4 x 30-120 µ, and the conidiophores are amphigenous, 4-5 x 25-85 µ. In fact, according to my key, it meets the characters of *C. sorghi* E. and E. (Jour. Mycol. 3:15. 1887)." Dr. Chupp suggested that it would be important to determine if the fungus involved would attack sorghum.

References: Gilman and Archer (262); Underwood and Earle (732).

CERCOSPORA SEMINALIS Ell. and Ev., *False Smut*.

It is questionable whether this should be listed in a discussion of leaf spots because this particular fungus attacks the flowers of buffalo grass (*Buchloë dactyloides* (Nutt.) Engelm.), resulting in sterile seed balls containing the brown powder (conidia) of the fungus. The conidia are acrogenous, sub-hyaline, obclavate, granulose, 3- to 5-septate, 80-110 x 6-7 µ.

False smut is credited with being an important factor in reducing the yield of viable seed. Since re-grassing programs in some areas depend heavily on buffalo grass, false smut is important. Buffalo grass seed is usually pre-soaked before planting. Whether viable conidia of the fungus have any detrimental effect on the seedlings is not known, but no isolations have been made that indicate such is the case.

References: Ellis and Everhart (210).

CERCOSPORA SETARIAE Atk., *Brown Leaf Spot*.

This fungus produces a dark brown elliptical leaf spot with an indefinite pale border. It is reported on *Setaria lutescens* (Weigel) F. T. Hubb from Iowa. Tehon and Daniels (701) use the following key to distinguish three species of *Cercospora* on *Setaria*:

Conidiophores long, 50-120 µ

Spores 20-150 x 4-5 µ ..... *C. setariae* Atk.

Spores 45 x 1.5 µ ..... *C. striaeformis* Wint.

Conidiophores short, 17-40 µ ..... *C. setariicola* Tehon and Daniels

References: Atkinson (20); Tehon and Daniels (701).

CERCOSPORA SETARIICOLA Tehon and Daniels, *Brown-Bordered Leaf Spot*.

The old spots are elongate-elliptic with a cinereous center and a sharply delimited brown border. The spores are 4- to 12-septate, 30-90 x 3-4 µ. The writer has collected this fungus on *Setaria lutescens* at McCanna, North Dakota.

References: Tehon and Daniels (701).

CERCOSPORA SORGHI Ell. and Ev., *Leaf Spot*.

This is reported as a leaf spot on Johnson grass (*Sorghum halepense* (L.) Pers.) from Nebraska. It is common on sorghums farther south. The spores are said to be hyaline, 70-80 x 3 µ (Ellis and Everhart, 209). (See also discussion under *C. fusimaculans* above).

CERCOSPORELLA Spp.

Until recent years, there were no species of *Cercosporella* recognized on grasses. There are at present four known for the region. They may be distinguished by the following key:

A. Attacks base of culm causing foot rot, spores 30-80 x 1.5-3.5 .. *Cercosporella herpotrichoides* Fron

AA. Attacks leaves causing leaf spot or scald

  B. Causes an eyespot lesion on leaves of *Poa pratensis*, spores 45-90 x 3.6-5 µ .... *C. poagena* Sprague

  BB. Causes a scald or non-eyespot type of leaf spot

    C. Conidia subulate, 20-35 x 2.5-4.3 µ .... *C. subulata* Sprague

    CC. Conidia filiform, 40-105 x 1.5-3 µ.....*C. holci* Sprague

CERCOSPORELLA HERPOTRICHOIDES Fron, *Cercosporella Footrot*.

In the United States, the *Cercosporella* footrot is restricted to some high prairies in the winter wheat area in the Columbia Basin, where the precipitation is 14 to 25 inches and the climate not severe.

Fawn-color to white elliptical lesions with brown borders form at the ground line on the stems in early spring. Stromatic mycelium eventually covers the base of the culms with black, charred-appearing hyphae. The culms break over at this point. Seriously diseased fields have characteristically pale green leaves and smaller heads than normal. Later, so much of the grain may be broken over and tangled together that harvesting is very difficult.

Winter wheat and wheat relatives (*Triticum* spp.) and also barley (*Hordeum* spp.) are susceptible, while rye is more resistant and oats highly so. *Aegilops* spp. (Sprague, 655, 656), crested wheatgrass, *Agropyron inerme*, *A. riparium* Scribn. and Sm., *Bromus carinatus*, *B. inermis*, *B. tectorum*, *Koeleria cristata*, *Poa secunda* Presl, and

Sitarion hystrix have all been found carrying the fungus.

Cercosporella herpotrichoides is greatly favored by open warm wet winters, which induce excessive growth in winter wheat or barley.

Olympia barley, Rex, Hymar, or Holland wheat (High Prairie, Washington) are preferred over bearded Turkey types of wheat in areas where this footrot occurs. Short straw is preferred to tall. Seeding should be delayed in the fall for a few days past the optimum date to reduce the chances of excess vegetative growth. Calcium cyanamid, 100 lbs. per acre increased yield.

References: Adam (4); Foëx and Rosella (233, 234); Fron (240); Glynne (264-267); Gorter (280); Heald (314); Moritz and Bockmann (476); Oort (494); Saxby (584); Sprague (620, 622, 624, 631, 635, 643); Sprague and Fellows (671).

CERCOSPORELLA HOLCI Sprague, Buff Scald or Tan Leaf Spot.

This fungus is very common in western Oregon and Washington on Holcus lanatus. The spots are tan, yellow-bordered to darker buff or tawny, elliptical or extensive scald-like lesions on any or all leaves of a plant. They develop in mid- to late- winter or early spring. In severe cases the injury resembles frost scalding or snow injury.

Conidia (1- to 9-septate, 40-103 x 1.5-3 µ) are produced in great numbers in winter, but in spring the conidia may be entirely absent. Such late spring lesions have been called nonparasitic by early workers who had not collected the fungus in the cold wet winter weather. This fungus is probably one of the reasons why velvet grass is not a satisfactory crop for pastures in western Oregon.

Reference: Sprague (634, fig.1).

CERCOSPORELLA POAGENA Sprague, Cercosporella Eyespot of Kentucky Bluegrass

An eyespot lesion caused by this fungus has appeared in two places in western Oregon on Kentucky bluegrass. The lesions are circular to sometimes elongate, brown with yellowish border, often straw color in the center and hence forming an eyespot type of injury.

The spores are hyaline, elongate, broadly filiform to obclavate with bases blunt, tapering, with the apices either abruptly acuminate or attenuate at the tips, 4- to 7-septate, 45-90 x 3.6-5 µ. It is known only from Forest Grove and East Corvallis, Oregon, and occurs in mid-early spring.

Reference: Sprague (657).

CERCOSPORELLA SUBULATA Sprague, Leaf Blast.

This fungus was originally described from a few gray to olive buff scald-like lesions on a herbarium sheet of a specimen of *Melica subulata* (Griseb.) Scribn. collected in the Ochoco National Forest in eastern Oregon. Since then it has been found on *Deschampsia caespitosa* (L.) Beauv. in the Montana mountains, in three places in western Oregon on *Festuca rubra* and on *Melica bulbosa* in the Big Horn Mts., Wyoming.

In pure culture on potato-dextrose agar an isolate from *F. rubra* produced a slow-growing fawn-color cottony growth that formed a few scattered conidia for a short time before staling.

The fungus is somewhat of a mystery as it appears to be both scarce and widespread, that is, it is never found in any abundance but has been found over a wide area.

The conidia have a characteristic, subulate shape with a whip-like distal portion. The conidia are 20-35 x 2.5-4.3 µ, mostly 28-33 x 2.8-3.5 µ. This fungus is now considered distinct from *Cercosporella* (Sprague, 668, in ms.).

References: Sprague (634, fig. 2, *A*, 668).

CLADOSPORIUM HERBARUM Lk., Mold.

See *Mycosphaerella tulasnei* (Jancz.) Rothers, its ascigerous stage.

CURVULARIA SPP., Mold.

These fungi sometimes cause molds, seed rots, leaf spots, seedling blights, and black kernels. In general they are saprophytic molds on dead plant parts.

Curvularia Boed. (55) has 3- to 4-celled, brown, fusiform spores, typically curved or bent, with one or two of the central cells somewhat enlarged. The species are universal molds on countless kinds of plants and on debris in the soil. Because their classification is still in a state of flux they are considered here as a unit. Groves and Skolko (300) have presented the latest information on the group and the reader is referred to their paper. On the basis of the ratio of length to width of spore, almost all of our material from the Northern Great Plains falls in the species *Curvularia geniculata* (Tracy and Earle) Boed., to which we have been referring specimens for several years. The spores of this species are brown, 3- to usually 4-septate, and 24-46 x 8-14 µ in pure culture. Our material resembles an Australian species, which Hynes (348) has reported as *C. ramosa* (Bainier) Boed. The spores from one of Hynes' collections average 32.6 x 13 µ, and those from another, 35.3 x 13.3 µ. According to the method used by Groves and Skolko, both of these would belong to the "geniculata" group and close to *C. geniculata*, but they place *C. ramosa* as a synonym under *C. inaequalis* (Shear) Boed. *C. inaequalis* has proportionately somewhat stubbier spores than *C. geniculata*. Groves and Skolko report *C. inaequalis* on seeds of grasses and certain other crops in Canada. As they state, the problem is by no means solved and needs further study. We prefer, for the present, to leave all of the "geniculata" material in *C. geniculata* although admitting that there are distinct differences in isolates.

Besides the great number of isolates of *Curvularia geniculata* obtained from the roots and seeds of many cereals and grasses in our area, we have isolated another species, confined largely to *Echinochloa crusgalli*. The spores are olive-green rather than brown, and are very short and thick, sometimes almost triangular in outline. These have been referred to *C. trifolii* (Kauff.) Boed., but need to be compared with several species of *Helminthosporium* for a possible earlier name. *C. trifolii* belongs in the 3-septate "lunata" group. *C. lunata* (Wakk.) Boed. itself is an exceedingly abundant mold in the tropics and probably occurs on rice and some weeds within the bounds of this report. It is a nuisance on rice grains in the southern United States.

Wernham and Kirby (762) reported *Curvularia* sp. as associated with a "going-out" or "melting-out" disease of *Poa annua* and *Agrostis palustris* (Metropolitan bent) during hot weather. This fungus grew best at 30° C and was inhibited if the temperature dropped below 25° C.

Bunting (81) did not find that *C. lunata* was conclusively parasitic on corn in the Gold Coast of Africa.

Hynes (345) found that there were 11 races of *C. ramosa* (*Helminthosporium*-M) associated with wheat in Australia. Hynes believed that this species or races of it were more virulent than either *H. sativum* or *H. tetramera* McK. (*C. spicifera* ?). Hynes' forms of *C. ramosa* differed considerably, one from another, in pure culture.

In the Northern Great Plains the writer (663) has found that most isolates of *C. geniculata* were nonparasitic on seedlings of many grasses and cereals; in a few cases, however, isolates were parasitic on certain grasses, but scarcely so on cereals. One culture, 367 B-6, isolated from seedlings of *Agropyron sibiricum* in mid-April, caused injury to roots of crested wheatgrass (*A. cristatum*), and moderate injury to sudan grass. Most isolates caused some injury, mostly pre-emergence killing, to proso millet and blue grama when added to the soil at seeding time. In general, however, *C. geniculata* appears to be a saprophyte on the roots, culms, leaves, and inflorescences of Gramineae and other plants in the northern United States.

In culture *Curvularia geniculata* produces a luxuriant dark gray to nearly black, more or less stringy growth on potato dextrose agar. Other isolates are velvety black, similar to some isolates of H. sativum, and such isolates produce quantities of spores.

Cralley and Tullis (131), Matsuura (441), as well as Boedijn (55), report that C. lunata could cause a seedling blight of rice. Martyn (437) reported C. lunata on brown discolored palea of flowering heads of rice from British Guiana. He was able to cause the condition by inoculating with spores of C. lunata and incubating under humid conditions.

Nigam (482) isolated C. lunata from red spots on sorghum leaves and found that the fungus produced, on 2 percent rice agar, alternate zones of pink and white mycelium, pink in daylight and white in darkness. In continuous darkness the colonies were a dense, bottle-green color.

Sanitary measures to inhibit these molds, particularly in warmer climates, would appear to be difficult. However, such places as rice straw stacks (Martin 435) may be sources of abnormally heavy infection and can be eliminated. Martin and Altstatt (436) also recommend burning all weeds and volunteer rice around fields, keeping late seedings away from early ones so that spores are not spread during threshing of early crops, and keeping the grain and shocks dry to avoid heating.

When C. geniculata is very common on moldy grass seed, it might be desirable to treat with New Improved Ceresan 1/2 to 1 oz. per bushel depending on the size of the seed (a bushel of small seeds involves a great deal more surface than a bushel of wheat). Most of the writer's trials have not shown great benefit from treatment of range grass seeds except those infected with Helminthosporium sativum.

References: Bainer (21); Boedijn (55); Bunting (81,82); Cralley and Tullis (131); Groves and Skolko (300); Henry (321); Hynes (345, 348); Lefebvre and Johnson (400); Martin (435); Martin and Altstatt (436); Martyn (437); Mason (439); Matsuura (441); Nigam (482); Sprague (663); Tullis (718, 719); Wernham and Kirby (762).

FUSARIUM SPP.

The number of species of Fusarium that occur on Gramineae is not great, but the artificial system of classification in general vogue has multiplied the number of their subdivisions so as to represent a considerable array of fungi. Since some of these fungi, notably F. oxysporum Schlecht., are only weak parasites, it is more practical for the cereal and grass pathologist to recognize the species, and, in many instances, to ignore most of the subdivisions. Thus, in the case of such a complex as F. oxysporum, we prefer to use the all-inclusive F. oxysporum Schlecht. em. Snyder and Hansen, and, for all practical purposes, not explore the multiplicity of forms that are involved, inasmuch as this and certain other species are of comparatively little consequence as parasites of cereals.

The student of *Fusarium* will naturally refer to Wollenweber's Fusarium autographice delineata (775), Wollenweber and Reinking's text (776), or the work of Raillo (518, 519). In North America, Snyder and Hansen (616) and Gordon (276, 277) have been followed. Gordon and the writer (278) have listed the common species of *Fusarium* isolated from Gramineae in the Northern Great Plains and this will serve as a guide to most of the species found in the plains country and westward. A key to these forms follows:

Key to Species of *Fusarium* on Western Grasses
(as grown on potato-dextrose agar in diffuse light at 70° F)

A. Typically producing red, pink, or wine color mycelium (sometimes color is scanty or absent in group with pio-shape (*Sporotrichum*) microspores)

B. Producing at least a few *Sporotrichum*-type microspores

C. Macrospores 1- to 3-septate .... *F. poae* (Pk.) Wr.

CC. Macrospores 1- to 5-septate .... *F. sporotrichioides* Sherb.

BB. No *Sporotrichum*-type microspores produced

C. Colony typically rosy pink; spore masses bright carrot color, often absent; macrospores somewhat acuminate at distal end, 5-septate average 45 x 4.1 µ, 7-septate 55 x 4.5 µ. (The common pink *Fusarium* on the roots of plants in the semi-arid Plains country) .... *F. scirpi* var. *acuminatum* (Ell. and Ev.) Wr.

CC. Colony white and rose or pink; spore masses carrot color; spores very narrow, 3-septate average 34 x 3.1 µ, 5-septate average 50 x 3.7 µ. (Common on the heads of Gramineae in moister regions) .... *F. avenaceum* (Fr.) Sacc.

CCC. Colonies bright carmine; spore masses orange red, often profuse; spores stout, not acuminate, 3-septate average 29 x 6.1 µ, 5-septate 38 x 6.6 µ, and 7-septate 46 x 7 µ. (Usually strongly parasitic) .... *F. culmorum* (W. G. Sm.) Sacc.

CCCC. Colonies carmine or darker; conidial masses bright orange; spores longer than in *F. culmorum*, proportionately narrower, 3-septate average 41 x 4.3 µ, 5-septate average 51 x 4.9 µ, 7-septate 73 x 5.4 µ. (Strongly parasitic) .... *F. graminearum* Schw.

CCCCC. Colonies white and bright rose; spores small, scarcely heeled, 1- to 3-septate, 1-septate average 16 x 2.8 µ, 3-septate 25 x 3 µ .... F. nivale (Fr.) Ces.

AA. Typically producing a peach-color, later buff to nearly brown mycelium; macrospores typically acuminate on distal end

B. Macroconidia 3- to 5-septate. (Common on grass roots) ..... F. equiseti (Cda.) Sacc.

BB. Macroconidia 3- to 7-septate, slightly more acuminate at apex than F. equiseti. (Appears to be much less common than F. equiseti, and very similar)......................... F. scirpi Lamb. and Fautr.

AAA. Typically producing white or bluish mycelia

B. Microspores produced in chains; growth generally white on potato-dextrose agar .... F. moniliforme Sheldon (The spores of var. subglutinans are produced in heads or false heads which are clusters of spores adhering temporarily)

BB. Microspores not produced in chains

C. Colonies white, soon showing lavender, blue, purplish, or less often pink or even isabelline in the depth of the medium; mostly aseptate microspores, 7-10 x 2.1-3 µ; terminal and intercalary chlamydospores numerous. (Very common in roots of grasses in the Plains country) .... F. oxysporum Schlecht. em. Snyder and Hansen

CC. Colonies becoming intensely blue in the depth of the medium; spore masses dirty cream to brownish; macrospores long cylindrical, fusiform, 3-septate 28-42 x 4.1-6.2 µ, 5-septate mostly 42-51 x 5-6.3 µ. (Saprophytic) .... F. solani (Mart.) Appel and Wr.

This key is useful only in a general classification of the rootrot, mold, and scab fungi on Gramineae but has some value in aiding workers who still class all Fusarium fungi as "spp."

References: Bennett (39); Carrera (93,94); De Haan (146); Gordon (276, 277); Gordon and Sprague (278); Padwick (500); Raillo (518, 519); Simmonds (609); Snyder and Hansen (616); Wollenweber and Reinking (776).

FUSARIUM AVENACEUM (Fr.) Sacc., Mold and Stem Rot.

This species apparently prefers marine or moist climates. It sometimes occurs as a parasite on rust spores on grasses in the western United States during rainy periods. The writer has seen it on a stem canker of orchard grass in the Cascade Mountains, Oregon. It has not been found on any rootrot material from North Dakota, although it occurs not far north of there in Canada (Gordon, 275). Johnston and Greaney (375) present evidence to indicate that it is a weak parasite. The fungus is readily recognized by its narrow macrospores.

References: Bennett (32); Gordon (275); Gorlenko (279); Johnston and Greaney (375); Wollenweber and Reinking (776, fig. 2, p. 52).

FUSARIUM CULMORUM (W. G. Sm.) Sacc., Rootrot and Head Mold or Scab.

Fusarium culmorum causes preemergence killing, stunting, and brown rootrot of cereals and grasses. The bases of some plants such as oats are sometimes covered with pink spore masses. It sometimes causes pink head mold or scab, and may even cause a small red-bordered sheath and leaf spot on wheat in the early season, as noted in the Palouse area of Washington. While the fungus is scarce in the Northern Great Plains, it is very common from central Montana westward. In the coast region, it and crown rust (Puccinia coronata Cda.) make the growing of oats somewhat hazardous. It is important east of the Great Plains also. In the Pacific Northwest it is an associate of Cercosporella herpotrichoides and of Helminthosporium sativum (dry land rootrot). Ledingham (399) found that F. culmorum was not inhibited by H. sativum but that the latter was inhibited by F. culmorum. There is increasing evidence that the various components of "common rootrot" are not entirely compatible.

Fusarium culmorum rootrot is one of the causes of red leaf in oats in Oregon and Washington (Sprague, 644). This symptom is particularly apparent in the Willamette Valley and in the vicinity of Moro, Oregon. Inoculation trials show that isolates of this fungus from North Dakota and Oregon are destructive parasites, far more parasitic than F. scirpi var. acuminatum.

The name Fusarium culmorum has been a catch-all for any pink or carmine tinted fungus in the United States. Very often F. scirpi var. acuminatum has been called F. culmorum, and the name has been used even for the entirely distinct F. equiseti and F. oxysporum. This accounts for the tendency to consider F. culmorum as a quasi-parasite of slight importance in some areas. Quite to the contrary, it is essentially as parasitic as F. graminearum; and where it occurs in quantity, it is to be reckoned with as a major problem, as it is in Canada and in the Pacific Northwest.

References: Bennett (32); Blair (50); Broadfoot (68, 69); Foster and Henry (236); Greaney (283); Ledingham (399); Rose (541); Sadasivan (561); Samuel and Greaney (575); Shen (603); Simmonds (607, 608); Sprague (663); Sprague and Fellows (671); Tyner (722, 723); Vosbein (748); Walker (750).

FUSARIUM EQUISETI (Cda.) Sacc. and F. SCIRPI Lamb. and Fautr., Secondary Rootrots.

These two similar species belong in the Gibbosum group which have the distal end of the macrospores pinched or narrowed. F. equiseti represents about 50 percent of all Fusarium spp. isolated from roots of Gramineae in April to June in the Northern Great Plains and is exceeded in numbers during the summer only by F. oxysporum. It first produces a peach color or apricot-tinted, cottony colony that later turns buff or medium brown. Microspores and later macrospores are produced in considerable numbers when grown in north light on potato dextrose agar. Putty color masses of macrospores, often without pseudopionnotes, are formed later. Neither of these species appears to be parasitic on cereal seedlings in trials at Mandan, North Dakota. (Sprague, 663). Bennett (34), however, found English strains of Fusarium scirpi var. pallens F. T. Bennett that were mildly parasitic on wheat and barley, while Johnston and Greaney (375) found that F. equiseti was moderately parasitic on older cereal plants. The isolates from the Northern Great Plains usually do not even cause destructive seed rots although at times they may reduce stands of blue grama to some extent, as do many weak parasites and molds (Sprague, 663).

References: Bennett (34, 37); Gordon and Sprague (276); Johnston and Greaney (375); Sprague (658, 663).

FUSARIUM GRAMINEARUM Schw., Seedling Blight, Scab.
(Ascigerous stage, Gibberella zeae (Schw.) Petch)

This well known cause of scab in cereals has been the subject of intensive study in the Middle West. An outline of recent studies up to 1940 is given by Dickson (160).

Fusarium graminearum is especially prevalent in southern Minnesota (Hanson, 305, 307) and is important westward into eastern South Dakota and the Red River Valley in extreme eastern North Dakota on spring wheat and barley. It is isolated occasionally from the roots of grasses in North Dakota west of the region where it occurs on cereals. It has been obtained from roots of Agropyron subsecundum, A. cristatum, and Agrostis sp. (P. I. 131,533) in western North Dakota, and from leaves of Poa pratensis near Jackson Hole, Wyoming, collected during very rainy weather in August 1941. It was isolated from barnyard grass and Hordeum nodosum growing in a moist ditch at Newell, South Dakota. It has not been reported authentically from the Far West. All cases attributed to it in western Oregon have proved to be F. culmorum. Conners (122) indicates that it is rare in Manitoba.

References: Bennett (33); Conners (122); Dickson (159-161); Dickson et al., (162); Eide (200); Goddard (269); Hanson (305, 307); Henry (322); Ho and Melhus (330); Immer and Christensen (352); MacInnes (422); McIndoe (444); Melhus (459); Pearson (507); Senn (598); Sprague (663); Tu (714, 715).

FUSARIUM MONILIFORME Sheldon, Corn Ear Mold, Seed Rot.
(Ascigerous stage, Gibberella fujikuroi (Saw.) Wr.)

While this is a common mold on corn ears in the South and Middle West, it is somewhat less abundant in the Northern Great Plains, although Edwards (195) found it to be common on corn seed from Nebraska, and Hoppe (339) reported it as abundant even into Colorado. Boyle (62) reported that Ray isolated it from corn stalks from Pasco, Washington. It has been isolated by the writer from the roots of corn, sorghums, millets, and a number of grasses during the summer time in North Dakota. Our inoculation results indicate that it is a weak seedling parasite on small seeded grasses.

Recently Edwards (197), working with F. moniliforme and F. moniliforme var. subglutinans Wr. and Reinking, found that because the corn seed contained sufficient nutrient for independent seedling growth for 10 to 12 days, soil fertility did not influence the action of the parasite on the plant during this critical period.

References: Boyle (62); Dickson (160); Edwards 195-198); Ho (327); Hoppe (339); Koehler (385); Koehler and Dungan (387); Koehler and Holbert (388); Leonian (402); Sprague (663); Ullstrup (726, 728).

FUSARIUM NIVALE (Fr.) Ces., Snow Mold.
(Ascigerous stage, Calonectria graminicola (Berk. and Br.) Wr.)

In the United States, the status of snow mold due to Fusarium spp. has been in considerable confusion. It is said to be a common cause of turf injury in the Far West and from Minnesota eastward. Just how much actually is due to F. nivale is not known for certain. Fusarium snow mold is very common in Oregon during open rainy winter weather. Small, more or less circular areas, with a fringe of white or pinkish mass of mycelium and spores, are sometimes very conspicuous in bent grass lawns (Agrostis tenuis, A. palustris). Rhizoctonia solani and Fusarium culmorum, among other fungi, are prominent, but a species of Fusarium with a preponderance of 1-septate heel-less spores is most common, and this, at least, is referable to F. nivale but culture work and critical study are certainly needed.

A similar fungus with small falcate spores occurs on overwintering, lax leaves of *Bromus tectorum*, *B. carinatus*, *B. rigidus* Roth, *Hordeum murinum* L., and *H. nodosum* in the Columbia Gorge region of Oregon and Washington.

It is not unlikely that *Fusarium nivale* has been confused with *F. oxysporum*, although the species seem to develop at somewhat different seasons of the year in Oregon and Washington. In the eastern United States, recent work has shown that part of the snow mold is caused by *Typhula itoana*.

What is called *Fusarium nivale* occurs on *Agrostis alba*, *A. palustris*, *A. tenuis*, *B. commutatus*, *Festuca rubra*, *F. rubra* var. *commutata*, *Poa annua* and *P. pratensis* in Oregon; on *A. palustris* in Washington; and on *Hordeum vulgare*, *Secale cereale*, *Agrostis alba*, *A. canina*, *A. tenuis*, *A. palustris* and *Festuca rubra* in Minnesota. *F. nivale* var. *majus* Wr. (Wollenweber and Reinking, 776, p. 43, fig. 2, *a*) has been observed on winter leaves of *Agrostis palustris* in Lincoln County, Oregon.

References: Andren (12, 13); Bennett (35); Dahl (136); Dennis (151); Markvich (434); Monteith and Dahl (472); Nilsson (483); Sprague (655, 656); Wernham (761); Wollenweber and Reinking (776).

FUSARIUM OXYSPORUM (Schlecht.) emended Snyder and Hansen, *Secondary Rootrot and Seed Rot*.

While this fungus is very common on the roots of Gramineae, particularly during the summer, it does not appear to be very parasitic. The writer obtained moderate seed rot in some small-seeded grasses such as blue grama and in proso millet but on cereals the fungus was scarcely parasitic (Sprague, 663). Johnston and Greaney (375) obtained the same results on cereals. Simmonds and Ledingham (610) report *F. oxysporum* as nonparasitic on wheat and barley and slightly parasitic on oats.

The pink coloration in dead roots of oats and to some extent barley and wheat is largely due to a saprophytic development of *F. oxysporum* (Sprague, 663).

References: Gordon (276); Gordon and Sprague (278); Johnston and Greaney (375); Simmonds and Ledingham (610); Snyder and Hansen (616).

FUSARIUM POAE (Pk.) Wr., *Silver Top, Secondary Rootrot, False Scab*.

Poa pratensis is affected with a disease called silver top. The heads turn white and die prematurely. They are covered with a pale buff mold growth of *Fusarium poae*, associated with a species of mite (*Pediculopsis graminum* (Reuter) in some cases. Heald (313) showed a similar association of *Fusarium* and mite in bud rot of carnation, while Stewart and

Hodgkins (686) reported it on carnation and blue grass.

F. poae occurs on a head blight of oats in the coast region of Oregon. Wollenweber determined an isolate from this material as F. poae (Sprague, 636). The culture on potato dextrose agar was buff-colored and produced many pip-shape Sporotrichum-type spores. The fungus appeared to be a secondary parasite and was usually found on sterile spikelets.

In the Northern Great Plains, F. poae is not abundant but it is sometimes isolated from the roots of Bouteloua gracilis, Bromus inermis, Panicum capillare L., P. miliaceum, and Zea mays. It is more prevalent in Minnesota, particularly northern Minnesota, on Poa pratensis, P. palustris, and Muhlenbergia racemosa. It was found associated with wooly aphids on smooth brome sheaths at Mandan, North Dakota. It occurs on timothy in Iowa (Gilman and Archer, 262).

The material in pure culture at Mandan developed white to powdery buff colonies that soon showed rosy tints. When the Sporotrichum stage is present in abundance the mycelium has a readily recognized loose powdery appearance.

Our inoculation trials show that some isolates of Fusarium poae are comparatively weak parasites or saprophytes. A few strains cause some seed rot in blue grama and millets. F. poae appears to be a relatively minor mold on Gramineae.

References: Gilman and Archer (262); Gordon and Sprague (278); Heald (313); Sprague (636, 663); Stewart and Hodgkins (686).

FUSARIUM SCIRPI VAR. ACUMINATUM (Ell. and Ev.) Wr., Pink Fusarium Mold, Secondary Rootrot.

This common pink mold causes yellow-brown lesions on the roots of some grasses and cereals but is usually associated with other fungi without any specific symptoms. It is a common saprophyte on practically all Gramineae in the western United States but causes some seed rot in spring and fall on small-seeded crops. It is only a weak parasite on wheat and barley and is apparently nonparasitic on oats.

This variety differs from Fusarium scirpi in the rose-pink, firm colony that is produced on potato dextrose agar. The mycelium tends to be coarse and breaks into characteristic stiff fragments in microscope mounts. It often produces no spores, although some isolates form carrot-red masses of macrospores slightly smaller than those of F. scirpi. Five-septate macrospores average 45 x 4.1 µ, and 7-septate, 55 x 4.3 µ. The curved spores have the typical Gibbosum shape, narrow at the apex. This fungus is readily distinguished from F. culmorum and F. graminearum by its firm felty growth with rose-pink coloration instead of the carmine and yellow-buff looser mycelium of the two scab-forming species, *F. culmorum* and *F. graminearum*. *F. scirpi* var. *acuminatum* is the common pink *Fusarium* of the prairie country. Less common are *F. scirpi* var. *compactum* Wr. and *F. scirpi* var. *longipes* (Wr. and Reinking) Wr., which Gordon determined as being present in North Dakota (Gordon and Sprague, 278). The former is distinguished by closely spaced septa in the macroconidia, and the latter by its exceptionally long macroconidia.

F. scirpi var. *acuminatum* apparently is favored by cool wet weather in March and April when it develops on the roots of overwintering perennial grasses and on young seedlings and sprouting seeds. It is a very common saprophyte following *Cercosporella herpotrichoides* in the Pacific Northwest, and is one of the components of dry land rootrot of winter wheat in the Great Plains. It also occurs in acid soils in the peat area of northern Minnesota and westward, and is common in soil of relatively high alkalinity. Cultures of this fungus isolated from red soil in Wyoming were particularly pale in color and evidently were a local race. Sometimes other cultures from various areas have shown marked buff colorations but these colorations are frequently induced by bacterial associates in the cultures. The writer's inoculation trials (663) have shown considerable variation in racial traits among the isolates, some being mildly to moderately parasitic, others saprophytic or essentially so.

References: Fellows (229); Gordon (276); Gordon and Sprague (278); Sprague (663).

FUSARIUM SPOROTRICHIOIDES Sherb., Secondary Rootrot, False Scab.

This fungus is readily confused with *Fusarium poae*. It has the same general host range and produces *Sporotrichum*-type microspores. The microspores of *F. poae* are 0- to 1-septate, citron shape or pip shape, mostly 6.6-14 x 4.7-6.4 μ, while those of *F. sporotrichioides* are usually longer, 5-28 x 2.2-3.8 μ. Macrospores of *F. poae* are 3-septate, 18-35 x 3.5-5 μ; in *F. sporotrichioides* they are 3- 5-septate, 25-56 x 3.4-4.5 μ.

Fusarium sporotrichioides is sometimes isolated early in the season from roots of Gramineae in the Northern Great Plains. It occurs on the roots of blue grama, side oats grama (*Bouteloua curtipendula*), smooth brome, *Elymus junceus*, *Festuca rubra*, *Hordeum jubatum*, *Panicum capillare*, and *P. miliaceum* in the area. It disappears rather completely during the growing season, but reappears as a pink mold or false scab on wheats and barley at or near harvest time. It is a minor component of "durum blight" but appears to be saprophytic in these instances. In general, tests by the writer (Sprague, 663) indicate that *F. sporotrichioides* is even less parasitic than *F. poae*. Its chief importance lies in the fact that growers are sometimes docked for "scabby" wheat when the grain is carrying only the relatively harmless false scab organism, *F. sporotrichioides*. *F. poae* appears to be more abundant in Manitoba than *F.*

sporotrichioides (Gordon, 275, 276), but in North Dakota the reverse has been true during recent years. F. poae is more common in northeastern North Dakota and in northern Minnesota, thus indicating relationship to the Manitoba situation.

References: Gordon (276); Gordon and Sprague (278); Sprague (663); Wollenweber and Reinking (776).

HELMINTHOSPORIUM

This complex and important genus was well presented about 20 years ago by Drechsler (176) although his work was limited to the Eastern States. At present the genus is being re-studied in that area and to some extent in the Plains region. The work with rootrots in the Northern Great Plains (Sprague, 663), has disclosed a number of forms that need critical taxonomic study.

HELMINTHOSPORIUM AVENAE Eidam, Helminthosporium Leaf Blotch of Oats (Leaf-stripe disease of oats in Scotland (Dennis, 149).

In summer, in the Northern Great Plains, the spots on oat leaves may be poorly defined brown areas merging into yellowish red or orange lesions. In winter or in cool weather, in Oregon, they are more frequently definite spots of red or purple anthocyanin shades surrounded by haloes of yellow. As they get older, the spots fade to straw color in the center. Dennis (149) reported pre-emergence killing in seedlings from seed-borne mycelia or spores in Scotland. Survivors showed leaf stippling. Later, spotting developed, often secondarily in late season, particularly on second growth oats.

The fungus requires cool moist growing conditions such as prevail in the winter, early spring, and fall in the coast region of Oregon, Washington, and in parts of the British Isles. In Oregon, H. avenae was isolated from the bases of diseased plants but appeared to have washed down the culm and developed as an associate of H. sativum, Ophiobolus graminis, Fusarium culmorum, Pythium spp., and Aphanomyces sp., which thrived in the highly acid soil of the coastal region where the diseased condition prevailed (Sprague, 639). H. avenae is somewhat lighter gray in pure culture than most isolates of H. sativum and it tends to form bracketed growths in test tube cultures, somewhat distinct from any formed by H. sativum. The spores are very different also; they are olivaceous or paler, cylindrical or slightly swollen in the middle, rounded at the ends, 4- to 6-septate, 80-110 x 15-16 µ, borne on scattered, stout cylindrical, multiseptate, fuliginous conidiophores, 150-200 x 9-12 µ.

While this fungus causes a minor leaf spot in many places, it is very serious in Scotland and Ireland and moderately important in western

Oregon. Seed treatment with New Improved Ceresan at 1/2 oz. per bushel is very necessary where the disease is serious. Varietal resistance was not noted in Scotland although the varieties Sovereign and Ascot were particularly susceptible. In Oregon, winter-hardy oats such as Support or Gray Winter are more tolerant to the disease than less winter-hardy ones such as Red Rustproof or Kanota of the red oat group (*Avena byzantina*). Wild oats (*Avena fatua*) carries the disease in Oregon, California, and North Dakota; and it occurs also on *A. barbata* Brot. at San Diego, California, and on *Arrhenatherum elatius* on Mt. Diablo, California.

References: Dennis (149, 150); Drechsler (176); Eidam (199); Ito and Kuribayashi (354); Muskett (479); O'Brien and Dennis (491); Rathschlag (526); Sprague (639).

HELMINTHOSPORIUM BROMI Died., Leaf Spot of Brome.

(Ascigerous stage, *Pyrenophora bromi* (Died.) Drechs.)

Minute dark brown or black spots with a yellowish halo appear on the first leaves in early spring in the northern United States. The spots elongate, become as much as 2 x 6 mm in size and, through coalescence, may cover much of a leaf area. The leaves then become yellow, wither, and die. The fungus is favored by cool weather, with temperatures ranging from 2° C to 10° C, and becomes less conspicuous as the season advances. It is very common on *Bromus inermis* in North Dakota, particularly in the Red River Valley (Weniger, 760). It occurs also, more or less incidentally, on the roots of this grass in the Northern Great Plains and has been collected also on leaves of *B. carinatus* at Wawawai, Washington; on *B. japonicus* Thurb. at Alzada, Montana, and nearby in Wyoming; on *B. tectorum* near Underwood, Washington; and on *B. rigidus* near Tumwater, Oregon.

The perithecial stage, *Pyrenophora bromi*, is well known (Drechsler, 176). Chamberlain and Allison (100, 101) recently reported that *P. bromi* was an important parasite on brome in Wisconsin during cool wet spring weather. The perithecia are considered to be more important in overwintering the fungus than the conidial stage, which latter does not live over winter. Varietal resistance was noted.

References: Chamberlain and Allison (100, 101); Diedicke (163); Drechsler (176, pl. 8, 9); Weniger (760)

HELMINTHOSPORIUM CALIFORNICUM Mackie and Paxton, Spot Blotch.

The writer (639) believes that this is a form of *H. sativum*, similar to if not identical with material studied by the writer in Lincoln County, Oregon. Mackie and Paxton described the fungus as a leaf spot parasite of barley in central California (Mackie and Paxton, 427; Mackie, 424). In recent years the name has disappeared from current literature.

HELMINTHOSPORIUM CYCLOPS Drechs., Leaf Spot.

The spots on Danthonia californica in the Willamette Valley, Oregon, are scattered, dark brown or black, and small, usually less than 0.5 x 2 mm in diameter.

Drechsler (176, pp. 729-730, pl. 32, 33) described this fungus on D. spicata (L.) Beauv. from Lisbon Falls, Maine. The Oregon collections (Sprague, 655) represent the only other report of this fungus as far as our records show. Neither the fungus nor its host is of very much economic importance.

HELMINTHOSPORIUM CYNODONTIS Marig., Leaf Mold.

Forms an effuse olive to fuliginous blotch on dry leaves of Bermuda grass (Cynodon dactylon) in the Bay region of California and southward. Drechsler (176, pp. 719-720, pl. 27) reports it also on Eleusine indica (L.) Gaertn. and Muhlenbergia mexicana in Florida and near Washington, D. C., and into New York state. It is practically omnipresent in the South but outside of disfiguring lawns it is not believed to cause much damage. Material seen at Davis Junction, California, in 1939 would indicate that it might be of more importance.

HELMINTHOSPORIUM DEMATICIDEUM Bub. and Wrób., Leaf Mold.

This fungus causes a leaf mold of sweet vernalgrass (Anthoxanthum odoratum L.) in northwestern Oregon. Its parasitic nature is not known. Drechsler (176, pp. 683-685, pl. 14) reported it on Agrostis alba and A. perennans (Walt.) Tuckerm. from the Atlantic coast.

HELMINTHOSPORIUM DICTYOIDES Drechs., Fescue Net Blotch.

A leaf net blotch characterized by a minute but well defined reticulate design on brown discolorations. The lesions are numerous and extensive. The leaves eventually wither and die, usually progressively from the leaf tips.

This fungus appears to be of some importance in the Far West. It was collected at Bingen, Washington, on Festuca occidentalis Hook. and recently a trace of it was found in some material of chewings fescue from northwestern Oregon.

Drechsler (174, 176, p. 677-679, pl. 11) reported it as the most important parasite of meadow fescue (F. elatior) in the eastern United States, where it is so common that it serves as a ready means of identifying the host in its vegetative stage.

HELMINTHOSPORIUM ERYTHROSPILUM Drechs., Red Leaf Spot.

This species has not been reported from the area covered by this report, but is likely to occur in the eastern part. The report of H. stenacrum Drechs. from Iowa possibly should be rechecked with this fungus. H. erythrospilum causes a true leaf spot on Agrostis, not a mold or streak as does H. stenacrum. During moist weather, it forms numerous straw-color leaf spots with a reddish-brown border, 0.5-2.5 mm. During prolonged periods of rainy weather the spots more or less overlap, forming pseudozonate patterns. They are surrounded by a water-soaked area, which presents a halo-spot effect. After dry weather returns the leaves wither and brown.

Reference: Drechsler (184).

HELMINTHOSPORIUM GIGANTEUM Heald and Wolf, Zonate Eyespot.

This fungus was described from Texas. While it is generally confined to the southern part of the United States it occurs as far north as Michigan and Illinois. It has not been reported in the range of this article but it is likely to occur. The fungus is noted for its huge fragile conidia and for the destructive zonate leaf spot (eyespot) that it produces on many grasses, notably Bermuda grass.

References: Drechsler (176, 180, 182); Heald and Wolf (319).

HELMINTHOSPORIUM GRAMINEUM Rab., Barley Stripe.

The symptoms of this important disease are detailed by Drechsler (176). Previous to heading time, the leaves become streaked with yellow bands that sometimes traverse the entire length of the leaf. The streaks later become yellowish brown or brown and the plants die prematurely. The leaves eventually become ragged or shredded. Heads may be completely sterile and the undeveloped kernels more or less brown.

Barley stripe is not important west of the Red River Valley except in certain areas in California and scattered spots in western Oregon, and sometimes in the Palouse region of Washington and Idaho.

The use of New Improved Ceresan, 1/2 oz. per bushel, has reduced the seriousness of the disease. Infection of the seed is favored by high humidity at and following flowering time. The disease may be carried over as mycelium penetrating from the glumes into the seed coat, or it may be transmitted by conidia on the seed, or wind-borne. Infection of the seedling occurs at sprouting time and is favored by cold, wet soil.

Christensen and Graham (112) found that H. gramineum was polymorphic and multiracial. They found about 125 races showing some morphological differences in some cases and many variations in cultural characters. About 20 races could be distinguished by their relative virulence on 16 varieties of barley.

Shands (600) found that H. gramineum was somewhat adaptable to varying temperature conditions. Barley will grow at cool temperatures (12-16° C) as will H. gramineum, but the latter also developed well at cooler temperatures and also at 20° C.

The following varieties have been more or less resistant to stripe: Glabron, Trebi, Spartan, and Wisconsin barbless.

References: Åberg (2); Arny (16); Christensen and Graham (112); Dickson (160); Drechsler (176, p. 650-656); Johnson (373); Leukel, Dickson and Johnson (404); Majdrakoff (430); Nisikado (486); Paxton (506); Reddy and Burnett (529); Shands (600); Shands and Arny (601); Smith (110); Suneson and Santoni (693); Weniger (760).

HELMINTHOSPORIUM HADROTRICHOIDES Ell. and Ev., Mold.

Medium gray, linear streaks followed by withered, sometimes shredded leaves or vague spots on dead leaves. Material, probably saprophytic, found by the writer on leaves of Eragrostis cilianensis (All.) Lk. from Miles City, Montana, was determined by C. L. Lefebvre as H. hadrotrichoides. We also isolated the same fungus from the roots of this grass growing in sandy soil at Mandan, North Dakota.

References: Drechsler (176, pp. 710-711, pl. 23); Ellis and Everhart (211); Mitra and Mehta (470).

HELMINTHOSPORIUM HALODES Drechs., Mold.

This was originally described on Distichlis spicata (L.) Greene from the Atlantic coast, but it appears to be a fairly common saprophytic mold, causing secondary seed rot or possibly rootrot in Agropyron repens and Muhlenbergia japonica Steud. in plots at Mandan, North Dakota, and in Panicum miliaceum, Poa spp., Schedonnardus paniculatus (Nutt.) Trel., Setaria italica (L.) Beauv. and Setaria viridis in North Dakota, South Dakota, and Minnesota. The symptoms produced by H. halodes are vague, dark discolored, more or less bluish areas on the leaves, sheaths and culms, also a black mold on the inflorescence. The species is not recognized as being associated with any particular rootrot symptoms.

In culture the dark spores are somewhat longer and less "kneed" than those of Curvularia geniculata although some strains are confusable, when immature, with the 4-septate phase of this species.

Mitra (468, p. 287) described H. halodes var. tritici Mitra on root-rotted wheat from India. The conidia are cylindrical or elliptical with the distal end abruptly rounded and the proximal end tending to taper to an acute base with a prominent, protruding hilum. The spores are widest at their middle, straight or slightly curved, 2- to 9-septate (average 6), light yellowish brown to smoky brown, the two end cells being slightly lighter, 23-73 x 13-20 µ, mean 50 x 16.5 µ. The description resembles some of the material isolated from roots of various grasses at Mandan, North Dakota.

Most of the isolates of H. halodes have been saprophytes or have produced mild seed rots (Sprague, 663).

References: Drechsler (176, pp. 707-709, pl. 22, 23); Mitra (468); Sprague (663).

HELMINTHOSPORIUM INCONSPICUUM Var. BUCHLOËS Ell. and Ev., Mold.

Material that C. L. Lefebvre refers to this fungus causes a mold on withered leaves of Buchloë dactyloides, Bouteloua gracilis, and B. curtipendula in the Northern Great Plains. The mold is associated with vague, brown blotches and is sometimes isolated from roots of older plants.

Pammel, King, and Bakke (502) illustrated H. inconspicuum var. buchloës as having small, heavy-walled spores. Technically the fungus apparently is undescribed (nomen nudum). Nothing is known about its economic importance.

References: Pammel, King, and Bakke (502).

HELMINTHOSPORIUM MONOCERAS Drechs., Spotblotch.

Forms dark brown or chocolate color spots, 0.3-1 x 1-3 mm, on the upper leaf blades. The lower leaves become withered and are covered with similar, larger elliptical spots, sometimes 1.5 x 5 mm. The older spots on the dead leaves are faded to a dull medium brown. The leaf sheaths and the tissue at the base of the plants are a diffuse brown. Conidiophores appear after the death of tissue.

This fungus occurs on barnyard grass (Echinochloa crusgalli), but a similar fungus has sometimes been isolated from the roots of Panicum miliaceum and of Setaria viridis in the Northern Great Plains. (See also H. setariae Saw.).

The spores are yellowish when young but later darken to the same color as those of H. sativum, thus contrasting with the much paler ones of H. turcicum Pass. The spores are 40-150 x 15-22 µ, typically straight, and usually widest at the middle segment, gradually tapering toward the tip to

1/3 or 1/2 of the maximum width, then bluntly rounded, tapering towards the base to approximately 1/6 of the median diameter, the contours then curving gently into the protruding hilum, 3- to 10-septate, scarcely constricted.

Schweinfurth and de Thuemen (588) list H. flexuosum Cda. (Brachysporium flexuosum (Cda.) Sacc. on the culms and inflorescence of Echinochloa crusgalli in Egypt. Possibly this is the same fungus as Curvularia trifolii mentioned earlier in this article.

An undetermined species of Helminthosporium is listed from the vicinity of Sydney, Australia, on E. crusgalli (Noble et al., 488).

References: Drechsler (176, p. 704-707, pl. 20, 21); Noble et al. (488); Schweinfurth and de von Thuemen (588).

HELMINTHOSPORIUM POAE Baudyš, Mold.

Somewhat fragmentary material on Poa trivialis L. from Astoria, Oregon, (O.S.C. 10,330) and on Poa secunda from Klickitat County, Washington (O.S.C. 4) did not appear to belong in H. vagans Drechs. and was assigned with considerable hesitation to H. poae (Baudyš, 24), a little known species described from central Europe. According to a footnote by Drechsler (176, p. 688) this fungus has 2- to 6-septate spores, 36 to 73 µ long. The spots are yellowish with a dark brown margin. Drechsler compares his H. vagans not only with H. poae but also with Napicladium gramineum Pk., which latter is a synonym of Scolecotrichum graminis Fckl. (Sprague, 657). H. poae certainly needs critical study. Possibly it too may have some well known earlier name.

References: Baudyš (24); Drechsler (176, p. 688); Sprague (637, 655-657).

HELMINTHOSPORIUM SATIVUM Pam., King, and Bakke, Spotblotch, Rootrot, Seedling Blight, Black Point, and Dryland Rootrot.

The seedling phase of the disease is characterized by a slow, dark rot of the coleoptile region with injury spreading later to the cortex and small feeder roots. The seedlings of small grasses may be wiped out early or even killed before emergence (pre-emergence blight), but the injury is less spectacular than that caused by Pythium arrhenomanes. Such hosts as barley, which show stunting or killing of lower leaves, very often recover later with slight apparent ill effects if growing conditions are optimum for the host.

After the seedling phases have been passed, leaf spotting may occur. This is a brown blotch rather than a definite spot or stripe. Abundant spotting in late season on barley or wheat speeds up premature ripening of the grain. The fruiting bodies of the fungus may give the maturing plants a blotchy or olivaceous cast. Barley seed and glumes show dark brown stains that are accompanied by shriveling of the kernels. The basal portions of kernels are more likely to be discolored. Black point of wheat and other grains is partly due to H. sativum, and most of the injury that occurs at seeding time in the Northern Great Plains from seed-borne parasites is due to this fungus.

In winter wheat, injury due to Helminthosporium sativum is vague, particularly on wheat grown in the semi-arid regions. The more or less recognized term, "dryland rootrot" (or footrot), is used to designate a particularly vague type of injury in which the plants show pronounced stunting in more or less circular to irregular areas in the fields. The crowns of these plants, when bisected with a sharp knife, uniformly show a conical area of brown, prematurely dead or necrotic tissue. These areas of greatest injury are frequently associated with shallow soil, hard pan under layers, or other conditions unfavorable for the growth of the plant. In the dry, winter wheat regions, occasional white heads (sterile heads) develop in winter wheat showing dryland rootrot. These are particularly common in eastern Oregon and are a phase of premature killing of plants by the almost omnipresent H. sativum.

Helminthosporium sativum occurs on many hosts, but it is most important as a rootrot and kernel smudge or blight of wheat and barley. It has been reported on dozens of species of grasses as well as on oats, corn, and wheat relatives. In the Northern Great Plains, it has been isolated from the roots of 79 species of Gramineae. It is especially common on species of Elymus, Agropyron, Bromus, and Hordeum, and less abundant on species of Poa, which are resistant to some extent. The host range as established by seedling and seed inoculation trials in the greenhouse is very extensive.

H. sativum is world-wide in distribution in the temperate zone. It occurs in very acid soil (pH 4.8) in a region of very heavy rainfall (70-100 inches yearly) in Oregon, and is omnipresent in the arid and semi-arid parts of the western United States. While it is an important parasite of wheat and barley, it takes second place as a parasite of grass roots when compared with Pythium arrhenomanes. Its importance on grasses may have been somewhat exaggerated in the past. However, because it is so universally distributed, it cannot be dismissed as a minor parasite even on grasses.

As a component of dryland rootrot of fall-sown wheat, it is not considered as important as it is on spring grain. Its effect is, nevertheless, important in spite of its obscure nature.

Helminthosporium sativum has been studied in great detail by a number of workers. Christensen has shown that it possesses a large number of physiologic races; also, it is generally recognized as being readily influenced by environment. Changes in light or moisture, or the presence or absence of antagonists can change a single isolate to almost unrecognizably different sub-cultures. While H. sativum is able to thrive in cool and moist weather, often it causes greatest injury in drought periods that follow. The diseased plants have weakened root systems and are unable to supply the plant with water and nutrients as readily as do healthy plants with larger root systems.

Seed treatment (New Improved Ceresan, 1/2 oz. per bushel) is effective insofar as it destroys seed-borne H. sativum on cereals but soil-borne spores and mycelium are scarcely affected by seed treatment.

References: Andrews (14); Beckwith (30); Bolley (56); Brentzel (65, 66); Broadfoot (69, 71, 72); Broadfoot and Tyner (74, 75); Christensen (106-109); Christensen and Davies (110, 111); Christensen and Stakman (113); Dosdall (172); Dosdall and Christensen (173); Drechsler (176, pp. 690-704, pl. 17-19); Greaney (284); Greaney and Bailey (285); Greaney and Machacek (286); Greaney, Machacek and Johnston (287); Greaney and Wallace (288); Gries (292); Hanson and Christensen (308, 309); Henry (321, 322); Hynes (345, 348, 349); Johnson (372); Kuribayashi (394); Ledingham (399); Machacek (418); Machacek and Greaney (421); McKinney (445, 446); Mead (453, 454); Mitra (467, 468); O'Gara (492); Pammel, King, and Bakke (502); Pinck and Allison (516); Richardson (535); Russell (550); Russell and Ledingham (551); Russell and Sallans (552); Sallans (563-567); Sanford (578); Sanford and Broadfoot (580); Sanford and Cormack (581); Simmonds, Russell, and Sallans (611); Simmonds and Sallans (612, 613); Smith (615); Sprague (639, 654, 655 -661); Stakman (679); Stevens (683, 684); Stover (689); Tropova (712); Tyner and Broadfoot (724); Valleau (734); Weniger (760); Ziling (780).

HELMINTHOSPORIUM SETARIAE Saw., Spotblotch and Secondary Rootrot.

(H. setariae Lind)
(Ascigerous stage, Ophiobolus setariae Ito and Kuribay.).

This species is sometimes isolated from the roots of Setaria viridis and less frequently from S. italica in North Dakota. In Japan (Ito and Kuribayashi, 354) the fungus produces abundant dark brown spots or leaf blight. In North Dakota such spotting is less common but in the late season it frequently occurs, mixed with spots caused by H. sativum.

In the description of Ophiobolus setariae Ito and Kuribayashi (354), the conidial stage, H. setariae, is listed as having dark olivaceous spores that are fusiform, obclavate ellipsoidal, mostly somewhat curved, slightly broader at or somewhat below the middle, tapering towards both ends, 5- to 10-septate, 40-120 x 10-18 μ, with fragile walls.

Pure cultures resemble H. sativum macroscopically but the spores are narrower than those of H. sativum. A. G. Johnson determined New Jersey material (Haenseler, 302) as belonging to H. setariae. It was some leaf spot material on Setaria italica, collected at Beltsville, Maryland, sent by Dr. Johnson that permitted determination of Mandan and North

Dakota material as *H. setariae*, and not as *H. turcicum* to which the writer had been inclined to assign it. Inoculation trials at Mandan show that *H. setariae*, when added as a sand-bran inoculum to electrically sterilized soil, is somewhat pathogenic to *Setaria* spp., *Echinochloa crusgalli*, *Panicum miliaceum*, and *Bouteloua gracilis*, but is less parasitic on *Triticum aestivum* and *Agropyron cristatum*, and only moderately parasitic to *Sorghum vulgare* L. Indications at present are that the fungus is not important in North Dakota.

References: Elveden (218); Haenseler (302); Huang (342); Ito (353); Ito and Kuribayashi (354); Lind (408); Sawada (583).

HELMINTHOSPORIUM SICCANS Drechs., Brown Blight.

The leaf blight of *Lolium perenne* and *L. multiflorum* caused by this fungus is very common in the Willamette Valley, Oregon, in winter and in early spring. It is particularly prominent on uncut lawns, where the leaves in certain areas are nearly all killed back to their bases. The leaf spots are numerous, dark brown, measuring 0.1-0.3 x 0.2-1 mm, and so abundant that much of the leaf surface may be covered with a pseudo-reticulate scorching or browning.

The conidia of *H. siccans* are never dark olivaceous, as in *H. sativum*, but are subhyaline or light fuliginous, later becoming yellow, brownish, or brownish olivaceous. The spores are typically straight or slightly curved, usually subcylindrical or tapering slightly or markedly toward the apex, 35-130 x 14-20 µ.

H. siccans is one of the most important diseases of *L. multiflorum* in the eastern United States (Drechsler, 176, pp. 679-682, pl. 12). Diedicke (164) reported a species of *Helminthosporium* on *L. perenne*. *H. siccans* occurs also in Scotland (Dennis and Foister, 152, p. 274) and England (Sampson and Western, 571).

HELMINTHOSPORIUM STENACRUM Drechs., Leaf Mold.

The symptoms are indefinite and the conidiophores develop on withered leaves. Oregon material on *Agrostis tenuis* appears to be saprophytic. *H. stenacrum* is reported on *A. alba* from Iowa.

The spores in this species are subhyaline to yellowish, 53-135 x 15-23 µ, subcylindrical with hemispherical or hemi-ellipsoidal ends, or widest somewhat below the middle and tapering moderately towards the ends. The apical portion of the spore is sometimes narrowed and prolonged. The spores are 1- to 11-septate, scarcely or not constricted at the septa, the peripheral wall is thin and the dark hilum is included within its contour (Drechsler, 176, pp. 682-683). Usually it will not sporulate on nutrient agar.

HELMINTHOSPORIUM TERES Sacc., Net Blotch.
(Ascigerous stage, *Pyrenophora teres* (Died.) Drechs.)

The dark brown spots or streaks on barley leaves are about 1 mm long, at first, finally 20 to 25 mm long but narrow. Some streaks of brown pigment occur transversely that break the pattern into a dark brown reticulate design within the area of diffused brown, hence the term "net blotch". The blotch tends to form near the leaf tips. These blotches may sometimes occur on the hulls.

Net blotch usually is a minor disease; although widespread it is seldom serious. It is not common in the Far West, and is most frequent in the northern United States east of the Great Plains.

The spores of *H. teres* are similar to those of *H. avenae*, subhyaline at first, later greenish fuliginous or yellowish brown but lighter than in *H. gramineum*, thin-walled, with a retracted hilum, 1- to 10-septate, 30-175 x 15-22 µ.

Partial control is obtained by treating seed with New Improved Ceresan, 1/2 oz. per bushel, or by reducing the number of overwintering perithecia by sanitation methods.

References: Atanasoff and Johnson (19); Böning and Wallner (59); Drechsler (176, pp. 656-663, pl. 2,3); Johnson (367); Ravn (527).

HELMINTHOSPORIUM TETRAMERA McKinney, Rootrot and Mold.

McKinney (446) described this species as the cause of a mild rootrot of wheat in Texas. Conidiophores are dark olivaceous to brown, simple or compound, with septa 5 to 50 µ apart and with the conidia produced at irregular intervals. Conidia are chiefly 4-celled, borne in clusters of 2 to 3 to 50 or more, dark olivaceous to brown, usually rather symmetrical in shape, tapering towards the rounded ends, 20-41 x 10.2-20.4 µ, frequently 30-34 x 10.2-13.6 µ.

The writer has isolated a similar fungus from cereals and grasses in North Dakota, South Dakota, Montana, Wyoming, and Nebraska. The spores on potato-dextrose agar are dark olive smoky, relatively thin-walled, regularly elongate, elliptical, 3-septate, 23-31 x 8-12 µ, borne on simple or sparsely branched conidiophores. A number of attempts to produce rootrot lesions or even seed rot on various Gramineae with this fungus have been unsuccessful. The local fungus appears to be *Brachycladium spiciferum* according to a letter received from J. E. Machacek in 1941. *B. spiciferum* was transferred to *Curvularia spicifera* (Bainier) Boed., but without much justification as the regular elliptical spores are not in the least *Curvularia*-like. The fungus has small spores but could be placed in *Helminthosporium* or *Brachysporium*, according to Machacek. He believes that *B. spiciferum* differs from *H. tetramera*. The spores of the former may be smaller than in *H. tetramera*, and the non-parasitic nature of the former may indicate specific differences between the two. In our case we question whether *H. tetramera* proper has been found in the Northern Great Plains.

Brachycladium spiciferum is usually isolated from overwintering roots and crowns of perennial grasses and from roots and sprouting seeds of grasses and cereals in the early season and late fall. It produces a luxuriant dark gray-black colony on potato-dextrose agar. Spores are produced in moderate quantities but seldom in large numbers. McKinney stated that *H. tetramera* produced long, simple, or branched sclerotia composed of hard white pseudoparenchyma with an outer black layer or rind. Many hyphal strands developed from these rinds, but no conidia were found on them. However, McKinney did have conidia in pure culture, as he stated earlier, and there seemed to be little if any change in spore characters when the fungus was cultured artificially. Since *B. spiciferum* produces a readily growing gray-black cottony colony that resembles *Alternaria tenuis* Nees and shows none of the sclerotial development of McKinney's cultures, the two forms are possibly distinct. Machacek mentioned in a letter to the writer (May 2, 1941) that he had seen material on oats and barley from eastern Canada that is closer to *H. tetramera* than to *B. spiciferum*, although, as he points out, Hynes (348) has referred Australian material to *C. spicifera* while Mason has referred it to *H. tetramera*. The tendency during recent years appears to be to lump the two species together. While no critical taxonomic report is available, the group had been under study by Machacek, until current economic conditions interfered. Crosier and Weimer (132), who also had the aid of Machacek, concluded that *C. spicifera* was a saprophyte, although they did obtain mild seedling injury on *Poa pratensis*, *P. compressa*, *P. trivialis*, and *Agrostis alba* (*A. palustris*). Machacek points out in his letter to the writer that in Crosier and Weimer's paper the legends on the illustrations of *C. spicifera* and *C. geniculata* are transposed. Thomas (706) also failed to obtain injury with *H. tetramera* (*C. spicifera*). In 1937 (Anonymous, 1), *B. spiciferum* was reported as an associate of *R. solani* in a brown patch of lawns in New South Wales. Bensaude (40) obtained consistently negative results on wheat in Portuguese East Africa with a fungus also referred to *H. tetramera*. Some further study with the Texas material is indicated as being desirable.

References: Anonymous (1); Bensaude (40); Crosier and Weimer (132); Hynes (345, 348); McKinney (446); Thomas (706).

HELMINTHOSPORIUM TRISEPTATUM Drechs., LEAF MOLD.

This causes a gray mold on dead or withering leaves of *Holcus lanatus* in the humid parts of coastal Oregon and Washington. It was also found on moldy leaves of *Agrostis exarata* at Wells (now Camp Adair), Oregon.

In New York, Horsfall (349) reported leaf tip killing on Agrostis alba and orchard grass. Drechsler points out the contrast between the vague lesions caused by this fungus on red top (A. alba) and the definite leaf spots caused by H. erythrospilum (Drechsler, 184).

The spores of H. triseptatum are dark, olivaceous, ellipsoid or short cylindrical with hemispherical ends, 2- to 3-septate, 35-50 x 15-21 µ. The peculiar thickenings of the conidiophores, as shown by Drechsler, are diagnostic (Drechsler, 176, pp. 685-686, pl. 14).

HELMINTHOSPORIUM TRITICI-REPENTIS Died., Leaf Blight.
(Ascigerous stage, Pyrenophora tritici-repentis (Died.) Drechs.

Drechsler (176, pp. 667-670, pl.5-6) describes the symptoms on Agropyron repens as being vague, manifested in a gradual fading and necrosis of the leaves, which finally become gray and heavily covered with conidiophores and later with perithecia, particularly on dead culms. In Oregon, definite brown to fuliginous spots and streaks occur on the leaves of A. repens and these are followed later by general necrosis. On Elymus hirsutus Presl the dark brown spots were very abundant on all the leaves of some plants along the Santiam River, Oregon, in May.

In the Northern Great Plains saprophytic development is sometimes great on wheat leaves during rainy periods in later season; however, little evidence has been seen of parasitic activity in this region. On wheat the fungus is usually associated with Septoria nodorum and other fungi. Fungi similar to H. tritici-repentis are isolated occasionally from the roots of cereals and grasses in the Northern Great Plains. Isolates from the roots of crested wheatgrass cause preemergence injury in crested wheatgrass, blue grama, proso, Italian millet, Japanese millet, and slight rootrot in wheat (Sprague, annual report, manuscript, 1944).

The conidia are subhyaline, straight cylindrical, 1- to 9-septate, 45-175 x 12-21 µ. Drechsler (176) states that "the most distinctive peculiarity....is found in the shape of the basal segment which.....in profile is remotely suggestive of the horizontal aspects of the head of a snake, while the distal end usually is rounded off in hemispherical form."

References: Barrus (22); Conners (121); Drechsler (176); Johnson (369); McRae (452); Mitra (469); Nisikado (486); Raabe (517).

HELMINTHOSPORIUM TURCICUM Pass., Leaf Blast, Seed Rot.
(H. inconspicuum Cke. and Ell.)

A gray-green leaf blight of corn was seen in some experimental plots in Lincoln County, Oregon, some years ago, and it occurs also on *Sorghum vulgare* var. *sudanense* in California. *H. turcicum* is otherwise unreported west of the Rockies. Chilton (104) reported *H. turcicum* on seeds of sudan grass from South Dakota, while the writer has isolated the fungus from the roots of corn and sorghum in North Dakota at various times.

The conidia are typically subhyaline to yellowish brown, very thin-walled, straight or slightly curved, widest near the middle and tapering decidedly towards the ends, somewhat cone-shaped at the hilum end, with the apical end rounded off but not beaked, 1- to 8-septate, 45-140 x 15-25 µ. The hilum scar is minute but it is distinctly protruded. The fungus develops a luxuriant gray-black aerial mycelium on potato-dextrose agar.

This fungus depends on high humidity, long rainy periods, and a maturing host for its most severe action. Because it develops in late season, its effect is often more spectacular than serious. Sherbakoff and Mayer (604) reported a black ear rot of corn as due to *H. turcicum* in Tennessee, but no doubt it is *H. carbonum* (Ullstrup, 729). Chilton has shown that *H. turcicum* is seed-borne on sudan grass and potentially destructive. The disease is considered to be serious in the Tropics and it interferes with seed production in the United States, particularly in sweet corn plantings in the East. Its importance on the roots of corn, sorghum, sudan grass, proso millet, and species of *Setaria* in North Dakota is slight. The identity of these forms remains in doubt. Some of them are atypical for *H. turcicum*.

Sanitary measures that reduce inoculum help to control this disease. Ducomet (187) recommended wider spacing to increase aeration. Seed treatment with New Improved Semesan Jr. kills seed-borne spores. Recent work by Ullstrup (727-729) evidences the complexity of the *Helminthosporium* problem on corn.

References: Campi (90); Chilton (104); Drechsler (176, pp. 712-718, pl. 24, 25); Ducomet (187); Ellett (203); Elliott and Jenkins (205); Gentner (260); Lefebvre and Sherwin (401); Mitra (466); Nisikado (485); Nisikado and Miyake (487); Reinking (531); Sherbakoff and Mayer (604); Ullstrup (727-729); Valleau (734); Zhavoronkov (799).

HELMINTHOSPORIUM VAGANS Drechs., Bluegrass Leaf Spot.

The leaf spots are circular to elongate with prominent reddish-brown borders darkening to nearly black in the center and, later, some becoming lighter in the center. Occasionally the spots are prevalent, particularly near the crown, but sometimes they are scattered over the upper leaves.

The disease occurs on *Poa compressa* but is most abundant on *Poa pratensis*. It also occurs on *Poa arida* Vasey in plots at Mandan, North

Dakota. It is seldom serious in the Pacific Northwest, and even less so in most of the Northern Great Plains, but appears to be definitely more important from Minnesota and Iowa eastward.

Since *H. vagans* is favored by rainy weather it develops most actively during late winter and early spring in the Pacific Northwest and during late summer and fall in the Northern Great Plains. At Mandan, North Dakota, moderate injury occurs during September or even October.

Horsfall (340) found that copper-lime dust inhibited this fungus.

References: Drechsler (175, 176, p. 686-688, pl. 15); Horsfall (340); Sampson and Western (571); Sprague (657).

HELMINTHOSPORIUM SPP. on Various Hosts.

In addition to the instances cited a number of collections were either too fragmentary or too recently seen to justify cataloguing. Most of these collections have been forwarded to A. G. Johnson and C. L. Lefebvre for study.

The following are included in undetermined material:

Helminthosporium (*catenarium* Drechs.) on *Beckmannia syzigachne* (Steud.) Fern., from West Fargo, North Dakota, June 20, 1944. Mingled with various leaf molds and *Physoderma* sp.

Helminthosporium sp. on *Sporobolus neglectus* Nash, Mandan, North Dakota, September 4, 1944.

Helminthosporium sp. on *Gastridium ventricosum* (Gouan) Schinz and Thell., a fragment from the southern part of the Willamette Valley, Oregon, showing a small circular white leaf spot.

Helminthosporium sp., a leaf blotch on *Muhlenbergia asperifolia* from Ft. Totten, North Dakota.

The isolates from the roots of warm season hosts including *Panicum* spp., *Setaria* spp., sorghums, and corn need further study. No doubt most of the isolations from *Setaria* that are not assignable to *H. sativum* belong in *H. setariae*, but some few are close to *H. turcicum*. Most of these forms are distinctly less parasitic than *H. sativum*.

HETEROSPORIUM AVENAE Oud., Leaf Mold.

This mold is not uncommon on overwintering plants. While it is usually saprophytic, the writer has seen material on *Avena sativa* from Oregon;

on *Elymus condensatus* from Oregon and Washington, and from Jackson, Wyoming, and on *Phalaris arundinacea* from Nebraska, that appeared to show evidence of parasitic activity on the part of *Heterosporium avenae*. It is usually found in the early season. Conidiophores of this fungus on western material resemble those of *Scolecotrichum graminis* Fckl., but the cylindrical spores are echinulate.

Solheim (617) reported *Heterosporium avenae* on leaves, stems, and spikes of wheat from Laramie, Wyoming, collected in August 1930. The writer noted it on leaves of overwintering wheat in Klickitat County, Washington, some years ago. A similar species was also seen on leaves of *Bromus carinatus* from Mt. Hood, Oregon.

HETEROSPORIUM PHLEI Greg., *Leaf Spot*.

The spots on *Phleum pratense* are small, oval, 0.5 to 1 mm wide and 1-4 mm long, rarely larger. The center of the spot is light mauve, with a narrow madder-violet or dark nigrosin-violet margin fading to brown or sometimes intensifying to black. Sometimes intervening tissue becomes yellow, and severely infected leaves may die. The scattered, sharply defined spots usually distinguish this parasite from other spots on timothy. Spores are rarely produced in the field. The conidia are 1- to 6-celled, chiefly 1-septate, not constricted at the septa, echinulate, pale to dark brown, 13-57 x 6-14 µ, averaging 23 x 9 µ.

Jacques (359) found that the fungus grew rapidly on potato-dextrose agar. The colony was bordered by a white margin, surrounding the olive-green center in the outer portion of which four or five zones of different shades of green could be recognized. A certain amount of white aerial mycelium gave the center a grayish tinge. The medium showed a reddish or purplish coloration for some distance around the margin of the colony.

In the original description, Gregory (291) reported that the fungus grew slowly in pure culture and did not sporulate until a thallus of considerable size was formed. Jacques (359), working with this strain, found thatthe fungus produced spores abundantly in pure culture after only 4-5 days when the thallus was only 12 mm in diameter.

Jacques stated that *Heterosporium phlei* is possibly merely a physiologic race of some earlier-described species, such as *H. avenae* Oud., *H. graminis* McAlp., *H. hordei* Bub. or *H. phragmitis* Sacc.

Heterosporium phlei occurs on timothy in Oregon, Washington, and Idaho to a limited extent, particularly in prairie areas and along the coast where the rainfall is moderate to heavy. It is more prevalent in Minnesota and appears to be important at times in New York and in the Eastern States in general. The spores are able to germinate at from 3° to 33° C, with the optimum at 24° C. Since the disease has been noted in February, March, July, and August, the fungus is evidently adaptable to a wide range of temperature. H. phlei also occurs on Phleum phleoides (L.) Karst. at Pullman, Washington.

Horsfall (340) indicated that relatively satisfactory control could be obtained with Kolodust and somewhat less control with 300-mesh dusting sulfur. In most instances it would not pay to dust for this leaf spot alone.

References: Gregory (291); Horsfall (340, fig. 18, 19); Jacques (359).

MASTIGOSPORIUM SPP.

Key to species:

A. Spores with apical appendages .... M. album Riess
(Not reported from U. S.)

AA. Spores muticate, 3-septate

B. Spores 25-32 x 4.5-5.9 µ .... M. cylindricum Sprague

BB. Spores 29-90 x 9-17 µ ....
M. rubricosum (Dearn. and Barth.) Sprague

Most keys include only Mastigosporium album, which is readily traceable by its simple or forked, elongate, hyaline apical appendages, and for anyone not familiar with the large clear hyaline, 3-septate, cylindrical spores of M. rubricosum its determination is likely to be difficult with any available keys.

MASTIGOSPORIUM CYLINDRICUM Sprague, Brown Spot.

This very distinct species is known only from a restricted forested area in the Coast range of Oregon, on Bromus vulgaris. The brown spots are elliptical to elongate, finally confluent and mottled. The mycelium is mostly endophytic, somewhat coalesced beneath the upper leaf surface, coarse, hyaline or lightly tinted, producing short, stout conidiophores from which spores are developed by expansion of the distal portion and eventual abscission.

Reference: Sprague (648, fig. 1,b).

MASTIGOSPORIUM RUBRICOSUM (Dearn. and Barth.) Sprague, Eye Spot. (M. calvum (Ell. and Ev.) Sprague).

On Dactylis glomerata, dark purple brown flecks are formed, which enlarge and become elliptical spots with ashy-gray to fawn color centers, 1-8 mm long, somewhat restricted by the parallel leaf veins. Larger lesions show various shades of gray, ashy, or light fawn color with more or less purple, red, or ochre borders.

On species of Agrostis, the lesions usually are broader, elliptical, light brown with fawn centers, becoming an eyespot or frogeye spot with a broad red, or red and yellow margin.

On Calamagrostis and Trisetum the lesions are the same as on Agrostis, or are small brown flecks, 1- to 3-mm in diameter, with small gray centers, or are sometimes surrounded by fawn or pale buff-color tissue.

The large navicular, crystal hyaline, 3-septate conidia are formed by expansion of the hyphal tips. They differ from M. album in the complete absence of the simple or forked aseptate filiform apical appendages.

In the humid parts of Oregon, Washington, and Alaska, this is one of the most serious leaf spots, being particularly destructive to orchard grass, red top, and creeping bent (Agrostis palustris), and in the mountains it is very abundant on Calamagrostis canadensis.

This fungus develops during open winter weather in Oregon and Washington, and during rainy or foggy weather throughout the growing season. High humidity and dense stands favor its development. In Oregon it occurs commonly on lawns in late winter.

The Oregon fungus from Agrostis alba was found to be a distinct race from that on Dactylis glomerata (Sprague 640, 648). There also are differences in susceptibility of several species of Agrostis to the fungus (Sprague, 640).

References: Bondarzeva-Monteverde (58); Dennis and Foister (152, p. 276; Sampson and Western (570); Sprague (640, 648).

NAPICLADIUM ARUNDINACEUM (Cda.) Sacc., Black Leaf Mold.

This black leaf mold of Phragmites communis has been reported from Nebraska, and material from Pelican Rapids, Minnesota, and Devils Lake, North Dakota, collected by the writer, appears to be this species. Large streaks or coalesced areas form on the leaf tips of growing plants, sometimes apparently killing considerable tissue. Yellow or necrotic areas on some leaves indicate that the fungus possibly may be somewhat systemic. There does not appear to be very much written on this fungus. It is evidently not uncommon in marshy areas in Minnesota and North Dakota.

NIGROSPORA ORYZAE (Berk. and Br.) Petch, Dry Rot of Corn.
(*Basisporium gallarum* Moll.)

This is mainly a cob rot of corn. The cob tends to shred at the base or shank and sometimes the kernels are somewhat shriveled. Infected ears show black spores around the area where the ear was broken from the shank or at the base of kernels. Yellow kernels are often bleached or discolored yellow brown. The fungus may attack injured seed and rot it in the soil if the soil remains cold and wet after planting.

References: Durrell (191); Koehler (385); Mason (438); Reddy (528); Savulescu and Rayss (582, 582,a); Standen (680, 681).

OVULARIA HORDEI (Cav.) Sprague, Leaf Spot.
(*Ophiocladium hordei* Cav.)

In Europe this fungus causes an obscure spot on the leaves of barley, but in Wisconsin (Davis, 143, 144; Greene, 289), South Dakota, and Wyoming it occurs on the leaves of *Phalaris arundinacea*. In material collected along creeks in the Black Hills, South Dakota, and adjacent Wyoming village of Moxee, the writer noted prominent straw color to buff, later pale brown spots, which finally became covered with the chalky fruiting material of the fungus. The spots were amphigenous, elongate, striate, often 1-2 x 10-30 mm in diameter, finally more or less confluent and covering or killing most of the leaf surface. The spots were emarginate or were surrounded by a diffuse yellow-buff area. The conidiophores were in compact fascicles in neat rows between the veins of the leaf, emerging from stomata and arising from abundant yellow to mostly hyaline compacted or serpentinous hyphae. The conidiophores were 3-4.5 µ in diameter, 20-40 µ tall, tortuous, twisted or remarkably serpentinous particularly at the apex. The conidia were produced near the apex on the side of the conidiophores and, on breaking off, a slight hilum was left at the base of the elliptical to elongate ovate spores. The spores were hyaline, one-celled with an evident wall which appeared faintly roughened, 11-15.5 x 6-7.8 µ.

Jørstad (376) mentions that *Ophiocladium hordei* produces dark spots, bearing a white or pale pink coating produced by the conidiophores on barley leaves.

References: Cavara (99, p. 26); Davis (143, 144); Greene (289, p. 89); Jørstad (376); Sprague (666).

OVULARIA LOLII Volkart, Eyespot of Lolium.

The spores of this fungus are ellipsoid to ovoid-piriform, 15-18 x 10-11 µ, rarely 10-19 x 7-13 µ, borne in ashy spots with reddish borders. The size of the spores would indicate that this species is different from *O. pulchella* (Ces.) Sacc. but the writer referred one of his meager Oregon collections on *L. perenne* to *O. pulchella* and another to *O. lolii*, indicating that both species occur on this host, or more likely, that both belong in one variable species. The status of *O. pulchella* var. *lolii-italici* Ferr. has not been determined.

References: Saccardo (558, v. 18, p. 531); Sprague (627, 655).

OVULARIA PULCHELLA (Ces.) Sacc., Leaf Spot.

This fungus causes scattered spots on leaves and culms of *Agrostis alba*, *A. palustris*, *Arrhenatherum elatius*, *Festuca megalura* Nutt., *F. myuros*, *Holcus lanatus*, and *Lolium marschalli* Stev. in western Oregon, on *Agrostis alba* and *A. tenuis* in Utah, and on *Bromus carinatus* and *Glyceria elata* (Nash) Hitchc. in southwestern Washington.

The spots are usually elliptical. Those on fescues are brown or tan color, often on the stem or sheath; those on brome are gray; those on species of *Agrostis*, *Lolium*, and *Holcus* are red bordered, of an eyespot type. Except on annual fescues, the disease is seldom common. Fescue grasses that are growing in thick stands in sandy or open-wooded areas sometimes have a considerable percentage of the plants showing one to several spots.

Ovularia pulchella (Ces.) Sacc. (558, v. 4, p. 145) was originally described as *Ramularia pulchella* by Cesati (99a), and its description later amplified by Fresenius (239) as causing a purple leaf spot of *Dactylis glomerata*. The spores are few, crystal hyaline, ovoid, 8-12 µ long. Davis described *O. pulchella* var. *agropyri* J. J. Davis on *Agropyron trachycaulum* (*A. tenerum*) from Wisconsin (Davis, 141) as having spherical to oval spores 9-12 x 6-9 µ. Later he appeared to have considered this as being scarcely distinguishable from the species proper (Davis, 144, p. 102). See also *O. pusilla* (Ung.) Sacc. (558, v. 4, p. 140).

References: Cesati (99a); Davis (141, p. 714; 144, p. 102); Fresenius (239); Saccardo (558, v. 4).

PENICILLIUM SPP., Seed Rots.

Corn, sorghum, and to some extent wheat, *Agropyron cristatum*, and other grasses are injured in the soil before emergence by reduction in the starchy content of the seeds before the seedlings are developed. Most of the injury occurs during prolonged rainy periods in April or May (and in 1942 even into June) in the Northern Great Plains, or earlier in the Pacific Northwest. *Penicillium expansum* Lk. em. Thom is the most common blue mold on these seeds, but a green mold caused by *P. oxalicum* Currie and Thom (133) appears to be an important species on seed corn in the Middle West. This species invades the embryo, causing yellowing of the leaves of the seedling and a gradual dying and drying of infected seedlings before the sixth leaf has unfolded (Johann, 363; Johann et al. 366). The dead plants, which remain stiffly upright, show little or no decay of the roots. The fungus is essentially a saprophyte. The injury is apparently due to oxalic acid, which kills the plant tissue in advance of the fungus.

Seed treatment (New Improved Semesan Jr.) will help reduce the endosperm-destroying molds. Proper curing of corn seed is necessary. In the drier parts of the Northern Great Plains, seed molds usually are less important and if clean local seed is used, seed treatment of field corn does not often show any benefit. However, sweet corn and pop corn usually show definite benefit from seed treatment in this area.

References: Currie and Thom (133); Diachun (157); Johann (363); Johann et al. (366); Leukel and Martin (405); Marchionatto (433); Noll (489); Thom (705).

PIRICULARIA GRISEA (Cke.) Sacc., *Blast*.

Gray, ashy or water-soaked spots are formed on the leaves and culms. The conidiophores rise from the stomata in groups of 2 to 5, are simple or rarely branched, fuliginous, septate, and bear conidia in terminal scorpoid cymes. The conidia are ovate, 2-septate, 24-29 x 10-12 μ.

P. grisea is common on *Setaria* millets in North Dakota and South Dakota and also occurs on certain other hosts in the United States. It is not important in the Northern States, as it is in the warmer regions. The closely related, if not identical, *P. oryzae* Briosi and Cav. on rice (*Oryza sativa* L.) has been intensively studied by the Japanese.

References: Schwartze (587, p. 120, figs. 735, 736); Tanaka (698).

RHYNCHOSPORIUM SPP.

Key to species:

Conidia apically obliquely-beaked...... *R. secalis* (Oud.) J. J. Davis

Conidia cylindrical........................ *R. orthosporum* Caldwell

RHYNCHOSPORIUM ORTHOSPORUM Caldwell, *Scald*.

The spots on the leaves are lenticular at first, coalescing to form irregular water-soaked lesions, which later become gray, surrounded by a brown margin. In some cases, on *Dactylis glomerata*, the spots fade to light straw color.

The fungus is very destructive on *Alopecurus pratensis* L. at Corvallis, Oregon. It is moderately common on *D. glomerata* in that region, and occurs there on *Agrostis alba*, *Elymus glaucus*, *Lolium perenne*, and *L. multiflorum* also. While *R. orthosporum* differs distinctly from *R. secalis* in the absence of an oblique beak at the apex of the spore, there are sometimes collections in Oregon that are more or less intermediate between the two species. Both species occur on *L. multiflorum*.

R. orthosporum occurs on *Calamagrostis canadensis* in the Yellowstone National Park, Wyoming, and along Spearfish Creek in the Black Hills, South Dakota. Therefore, adding Caldwell's type on *D. glomerata* from Wisconsin, the fungus is scattered well across the Northern United States.

The material on *Elymus glaucus*, restricted to an area in Linn and Marion Counties, Oregon, may be an undescribed species or a variety with somewhat distinct morphology.

References: Caldwell (89); Sprague (655).

RHYNCHOSPORIUM SECALIS (Oud.) J. J. Davis, *Scald*.

The lesions are at first dark bluish-gray, water-soaked in appearance, later the collapsed tissue becomes light gray with a dark brown margin, sometimes irregularly zonate, often completely killing "scalded" leaves.

This fungus causes a serious disease of barley in Oregon, Washington, and California. Losses in winter barley in western Oregon and California often average 10 percent and losses up to 30 percent of the crop are reported. Even when all the leaves on some varieties have been 100 percent scalded the plants recover and give fair yields. This has erroneously led observers to believe that the temporary loss of foliage is unimportant. Wiebe, Caldwell (89, p. 176), and others have found this to be untrue. This disease is gradually becoming recognized as worthy of major consideration.

Besides barley, *R. secalis* occurs more or less spasmodically on a number of grasses and cereals in Oregon and Washington and scatteringly eastward as follows:

Oregon: *Agropyron dasystachyum* (Hook.) Scribn., *A. repens*, *Agrostis* *alba*, *Elymus glaucus*, *Hordeum jubatum*, *H. murinum*, *Lolium multiflorum*, *L. perenne*, *Secale cereale*.

Washington: *Agropyron repens*, *A. semicostatum*, *A. trachycaulum*, *Bromus carinatus*, *B. inermis*, *Elymus canadensis*, *E. condensatus*, *E. glaucus*, *E. junceus*, *E. triticoides*, *Secale cereale*.

Idaho: *Agropyron subsecundum*.

California: *Agropyron repens*, *Secale cereale*.

Minnesota: *A. repens*.

South Dakota: *Phalaris arundinacea*.

Wyoming: *P. arundinacea*.

North Dakota: *A. repens*, *P. arundinacea*.

The collections on *Phalaris arundinacea* are less strongly beaked than most of the other collections (see B.P.I. 80,456). The spores are 13-18 x 2.3-2.8 µ.

In his detailed study, Caldwell (89) recognized six highly specialized physiologic races, which were distinguished by their ability to attack one of six hosts: rye, barley, quack grass, smooth brome, Canada wild-rye, or *Hordeum jubatum*. None of these, except the race from Canada wild-rye, could attack a host species of a genus other than that from which it was isolated. The race from Canada wild-rye could attack *Agropyron trachycaulum*, which is more or less to be expected as fungi attacking *Agropyron trachycaulum* or other members of the genus would likely also attack some members of the related genus *Elymus*. No doubt, were all of the additional hosts tested for racial affinities, several unrecognized strains would now be found.

References: Bartels (23); Caldwell (89); Davis (141, p. 713); A. G. Johnson and Mackie (371); Mackie (425).

SCOLECOTRICHUM GRAMINIS Fckl., *Leaf Streak*.

The shape, color, and extent, of the lesions caused by this fungus vary with age and host species. In its most common condition it occurs as elongate gray, brown-ochraceous to stramineous streaks on the leaves with aniline to sulphine yellow borders in which the black clusters of conidiophores appear as minute dots in seried arrangement. Younger stages show water-soaked circular to elliptical lesions which are deep olive gray in the morning when dew-wet, and deep dull gray when dry. These spots become brown, purple-brown to ocher with gray centers, with a tendency to form streaks gradually as the leaves die.

This fungus is readily distinguished by the prominent black densely fascicled conidiophores arranged in parallel rows as black dots along the surface. Without a hand lens, they are sometimes mistaken for pycnidia. Less frequently they may be plentiful enough to give a sooty mold aspect to the underside of the leaves. The spores are Indian-club shaped, i.e., fusoid-obclavate, 35-45 x 8-10 µ, 1- or sometimes 2-septate, olive brown.

The correct name of this fungus has never been settled to the satisfaction of all workers, although most of them use the old name, *S. graminis*, which Fuckel proposed in 1863 (241, No. 134). Horsfall (340) suggested that all available evidence indicated that *Cercospora graminis* (Fckl.) Horsfall would be a satisfactory name for the fungus. He stated that Von Höhnel (Centrbl. Bak. 2:60: 1-26. 1924) considered *Scolecotrichum* as probably invalid. Until the matter is settled, the writer uses the name that is recognized by most workers. Synonyms for the fungus include: *S. compressum* Allesch. (Hedw. 35(2): 34. 1896); *Cercospora graminicola* Tracy and Earle (Torr. Bot. Club 22: 179. 1895); *Passalora graminis* (Fckl.) Hoehn. (Centrbl. Bakt. 2:60: 1-26. 1924); *Passalora dactylina* Pass. (*In* Lindau, G. Rab. Krypt. Fl.1:8: 793-799. 1907); *S. graminis* var. *nanum* Sacc. (*In* Höhnel, F. von. Centrbl. Bakt. 2 etc. 1924); *Napicladium gramineum* Pk. (Sprague, 657) and probably *Cercospora poae* Baudyš and Picb. 25);(Chupp, in letter to Sprague, 657).

Scolecotrichum graminis is known to occur on at least 104 species of Gramineae in the United States, 94 of them being included in this report. Of these, 10 are species of *Agropyron*; 6, of *Agrostis*; 4, of *Alopecurus*; 8, of *Bromus*; 9, of *Elymus*; and 13, of *Poa*; as well as 44 species of 22 other genera. The host range on Gramineae is almost unlimited. Horsfall listed only 28 host species in 1930; Seymour, about 27 for the entire United States. Still further study will no doubt add many more to the host range of this omnipresent species. *S. graminis* is particularly common on the Pacific Coast, but is abundant in the Plains country as well. It ranks as one of our most important leaf spot diseases of timothy, orchard grass, blue grass, tall meadow oats grass, and red top. Sometimes it is less serious than it appears to be because the fungus sporulates profusely in late season and develops saprophytically on many hosts on which it is only mildly parasitic. It is frequently secondary to other fungi. It is not important on cereals but sometimes occurs on rye in the coast region of Oregon. Once it was found on 40 percent of the leaves of rye in early May near Alsea, Oregon, (Sprague, 641) and on another occasion it was found on rye heads in the same general area. Guarch (301) reported *S. graminis* var. *brachypoda* Speg. on rye in Uruguay, and Jankowska (361) lists it from Poland on rye, and also as causing slight injury to wheat. Shitakova-Roussakova (605) reports the disease as widely distributed and of moderate importance on rye in the Soviet Union. She found some varietal resistance. Landaluze (397) reports *S. graminis* as a secondary parasite of rye in a hilly region in Spain where the soil was pH 5.4. This condition is similar to that encountered near Alsea, Oregon, where the soil is highly acid (pH 4.9-5.5) and very deficient in nitrogen and phosphorus. Probably the injury on rye is not representative of strong parasitism in many cases.

Tabulation of about 250 collections of *S. graminis* shows that this fungus may be found any month of the year, but in Oregon its greatest activity is from March to July with a secondary development in the fall after the rains start again. Injury is greatest on older plants in spring. In the Great Plains, the fungus develops in May and June, but profusely fruiting material has been collected from May until late September.

This fungus needs critical study to determine its physiological status. Morphological variants occur (as on *Poa ampla* Merr. in Klickitat County, Washington), but whether they are anything more than variations due to host and humidity is not known.

Information on the control of this disease is scanty. Certainly grass weeds such as *Hordeum jubatum* and *Beckmannia syzigachne* probably aid in spreading it. Burning over fields no doubt reduces the injury from this fungus, which is able to increase its inoculum through saprophytic or semi-saprophytic development while the host is dormant or necrotic in very early or late season.

References: Fischer, et al. (231); Fuckel (241); Guarch (301); Horsfall (340); Jankowska (361); A. G. Johnson and Hungerford (370); Krause (390); Landaluze (397); Nilsson-Ehle (484); Shitakova-Roussakova (605); Sprague (641, 657); Trelease (709).

SCOLECOTRICHUM MACULICOLUM Ell. and Kell., Leaf Spot.

Prominent, elliptical, dirty-white spots form on the broad, living leaves of *Phragmites communis*. Originally described from Kansas (Ellis and Kellerman, 217), this fungus has been collected several times in one locality on Young's Bay, near Astoria, Oregon. The fungus has not been studied critically nor compared closely with *S. graminis*. It has spores 20-22 x 8-11 µ borne on conidiophores 40 x 4-5 µ. *S. graminis* has spores 35-45 x 8-10 µ (Saccardo 558 v. 4: 348) borne on conidiophores, 90-100 x 6-8 µ.

SPOROTRICHUM SP.

This fungus causes an obscure leaf killing on *Agropyron spicatum*, *A. inerme*, and *A. subsecundum* in Washington, Idaho, and Montana. The stromata are barely visible to the naked eye as fine, white stippling on dried leaf parts. Spores, which are intimately associated with the branched septate hyphae, are 3-8 x 2.5-6 µ and secondary spores are produced by budding.

References: Sprague (668, 669).

STEMPHYLIUM SPP. (See *Alternaria*.)

Stemphylium botryosum Wallr. (Ascigerous stage, *Pleospora herbarum* (Pers.) Rab.) is the most abundant species, but it is of slight importance.

References: (Wiltshire, 768); (Groves and Skolko, 298).

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